HANFORD LABORATORIES OPERATION
MONTHLY ACTIVITIES REPORT
APRIL, 1957

65760

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Compiled By
Operation Managers

May 15, 1957

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

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PRELIMINARY REPORT

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TABLE I. HLO-FORCE REPORT AND PERSONNEL STATUS CHANGES

FORCE REPORT

Date April 30, 1957

	At close of month			At beginning of month			Additions		Separations	
	Exempt	Non-Exempt	Total	Exempt	Non-Exempt	Total	Exempt	Non-Exempt	Exempt	Non-Exempt
Chemical Research and Development	124	93	217	125	92	217	0	3	1	2
Reactor & Fuels Research & Development	139	89	228	138	91	229	1	0	0	2
Physics & Instrument Research & Development	57	25	82	60	25	85	0	0	3	0
Biology Operation	33	42	75	32	42	74	1	0	0	0
Operations Research and Synthesis	12*	3*	15	11	4	15	1*	0	0	1*
Radiation Protection	41*	198*	239	41	201	242	1*	1	1	4*
Laboratory Auxiliaries	42	195	237	41	195	236	1	3	0	3
Financial	15	31	46	15	31	46	1	1	1	1
Employee Relations	13	13	26	13	12	25	0	1	0	0
General	1	1	2	1	1	2	0	0	0	0
TOTALS	477	690	1167	477	694	1171	6	9	6	13
Totals excluding Internal Transfers	477	690	1167	477	694	1171	5	4	5	8

*Reassignment from Non-Exempt payroll

Composite Separation Rate -1.111
Separation Rate (based on separations leaving G.E. - .685
Controllable Separation Rate - .342

TABLE II. PERSONNEL STATUS CHANGES (1)
PROMOTIONS AND TRANSFERS

Date April 30, 1957

Component	PROMOTIONS			EXEMPT TRANSFERS (2)				NON-EXEMPT TRANSFERS	
				To HLO		From HLO			
	Exempt	Non-Exempt to Exempt	Non-Exempt	From Other HAPO	From Other G. E.	To Other HAPO	To Other G. E.	To HLO	From HLO
Chemical				0	0	0	0	0	0
Reactor & Fuels				0	0	0	0	0	1
Physics & Instr.				0	0	0	0	0	0
Biology				0	0	0	0	0	0
Operations Res. & Syn.				0	0	0	0	0	0
Radiation Protection				0	0	0	0	0	1
Laboratory Aux.				0	0	0	0	0	1
Financial				1	0	1	0	0	0
Employee Relations				0	0	0	0	0	0
TOTAL				1	0	1	0	0	3

(1) Data through 4/30/57
(2) Transfers within HLO not included

SUMMARY

RESEARCH AND DEVELOPMENT

1. Reactor and Fuels Development

Three seven-rod cluster fuel elements operating at ~60 kw/ft are two-thirds of the way to a 600 MWD/T test exposure in the KE reactor. Discharge is scheduled in May. Out-of-reactor 280 C water loop tests showed as many as three defective rods in one element would reduce nominal coolant flow one half.

Three cored insulated fuel elements have completed an exposure of about 700 MWD/T at ~50 kw/ft in the KW reactor. Examination is pending.

Two tubular ceramic fuel elements (1.474" OD x 0.375" ID x 8.850" length), consisting of 92% dense UO_2 clad in M-388, Ni-Al alloy, were fabricated and shipped to the MTR for irradiation at a calculated power generation of 50 kw/ft, beginning with cycle 87, May 13.

Ten Zircaloy-3 clad swaged oxide fuel elements were fabricated; the dimensions of these are: 0.375" OD, 0.035" wall of cladding, and approximately four inches long. Seven of the ten elements were sectioned for metallurgical evaluation; two of the remaining three elements, with oxide densities of 85% and 90% of the theoretical value, are scheduled for MTR irradiation in the near future.

Laboratory static autoclave corrosion tests have shown a new experimental aluminum alloy A-203X (5.5 wt % Ni, 0.3% Fe, 0.2% Ti) to be markedly superior to all previous aluminum alloys in corrosion resistance to deionized water at 370 C. Moderate to severe localized corrosion was observed on M-388 (Fe, Ni) and standard 1245 alloy jacketed fuel elements in the extreme downstream portion of test columns discharged from the H reactor.

The three KER water loops were placed in in-reactor recirculatory operation using dummy fuel loadings. Replacement of a canned motor pump on the K-3 loop was effected following a bearing failure.

Scope preparation for the PRPR is estimated to be 40% complete. The building and services criteria (second issue), charge-discharge criteria, reactor radiation monitor instrumentation criteria, power calculation instrumentation criteria, and reactor thermocouple criteria were issued for comment during the month. Better definition of the various reactor systems has resulted in a reduction in the diameter of the containment vessel from 90 feet to 80 feet.

The plutonium-bearing fuel elements and flux monitoring discs for the PRP reactor tests in the PCTR were completed and sent to the 300 Area.

2. Physics and Instruments Research and Development

Exponential measurements were made to determine the effect that enriching I and E slugs would have on the reactivity gains arising from loss of water from a reactor. These experiments were proceeding at month-end.

The first set of analog computer runs on the dynamic behavior of a reactor upon water loss were completed and sent to IPD for evaluation.

Final values of the reactivity parameters for large solid fuel elements, considered for the IPR design, were determined jointly with IPD personnel based upon experiments in the PCTR.

Experiments were run in the PCTR to determine k for several lattices of interest in the PRPR. All experiments were done in a 7" lattice and included a 7-rod cluster of oxide elements, a 19-rod cluster of oxide elements, and a cluster of 16 oxide and 3 Pu elements. Preliminary analysis of the results indicates a k less than 1 for the 7-rod cluster and greater than 1 for the other two, but no numerical values are yet available.

Experiments to determine the maximum safe enrichment which can be handled in solution in the Separations Plants without attention to critical mass limitations, reported last month, have continued. The value of this enrichment has been determined to be 1.05% and the most reactive concentration is in the H/U range of 7 to 8.

Exponential experiments are in progress to determine nuclear safety limitations for handling and processing enriched I and E slugs outside of reactors.

Experiments performed during the month provided striking confirmation of previous results which demonstrated that the classical atmospheric diffusion theories seriously under-estimate the concentration of contaminants at distances beyond 1,000 feet from the source in stable atmospheres.

3. Chemical Research and Development

The anomolous behavior of neptunium in the Purex Process has been traced to impurities in the solvent. A predictable course of action on the flowsheet for Np recovery can now be taken. It is planned to oxidize in the first cycle forcing the Np with the solvent followed by reduction in the second cycle. This results in Np going into the aqueous phase. Ion exchange can be employed to remove Np from this stream.

Favorable small scale laboratory studies for the concentration and purification of plutonium by adsorption on and elution from an anion exchange resin were duplicated by R&E of CPD on a semiworks scale. It was decided

to convert the Purex ion exchange system from cation to anion type resin. The change will require revised instrumentation for the Purex installation. Studies are in progress to define the new instrumentation.

The Flurex system for production of UF_4 from $UO_2(NO_3)6H_2O$ by electrolytic reduction and precipitation was moved closer to large scale operation. A trench type cell was demonstrated which permits scale-up with retention of the same characteristics as the single electrode system used in laboratory studies.

The chemistry of the NH_4F scheme for dissolution of zirconium was further defined. The optimum ranges for pH and reagent concentrations were characterized. Gas evolution is in accord with theory - 2 mols of H_2 and 4 mols of ammonia per mol of zirconium.

The adaptability of the new HA column internals to the proposed Purex Phase II flowsheet (2 cycles with backcycle) was investigated. Capacity factors of 3.5 were realizable with satisfactory losses and good scrubbing efficiency (based upon chloride removal).

Formation of mixed crystals of PuO_2-UO_2 from nitrate solutions by direct calcination in an inert gas atmosphere as opposed to reduction in a hydrogen atmosphere appears to be a possibility. Demonstration of the adequacy of this method would reduce equipment and operating costs as well as a potential safety hazard.

A potentially lower cost method for making plutonium-aluminum alloys from PuO_2 was explored. Alloys containing 1.6 and 15 weight per cent Pu were made by reaction of aluminum metal and plutonium oxide in a molten cryolite (Na_3AlF_6) system.

The application of x-ray fluorescence techniques was explored with existing instrumentation. It was possible to determine elements in the range from iron (Atomic No. 26) to silver (Atomic No. 47) at concentrations of 50 mg/l with a precision of ± 5.0 per cent. Elements from mercury (Atomic No. 80) to uranium can be determined in concentrations of 100 mg/l with like precision. Further improvements in sensitivity by a factor of 10 are believed achievable. A significant improvement in the speed and cost of analytical work should derive from this application.

Determination of plutonium and uranium in irradiated fuels was simplified by application of coulometric procedures. The procedure requires fewer manipulations, and smaller samples; hence, reduced radiation shielding. Precision is ± 0.5 per cent.

Application of gamma and beta energy spectrometry to measurements of activity in aquatic samples appears feasible for 17 isotopes. A precision of ± 3 per cent is attainable for 9 of the isotopes, ± 10 per cent for 4 and ± 25 per cent for the remaining four isotopes.

[redacted]

Studies on synthetic zeolites (sodium alumino silicate) as a retention media for fission products revealed that the removal of water from the gel by compaction or leaching results in loss of cesium from the gel. Strontium appears well fixed.

4. Biological Research

Calcium gluconate did not alter the therapeutic effectiveness of zirconium citrate in promoting the excretion of plutonium from rats. The zirconium citrate is better tolerated by the animals when mixed with calcium gluconate.

The accumulation of Cs^{137} in rats after 200 days chronic feeding was in close agreement with predictions based on results of single administration experiments.

One hour following intravenous injections Zn^{65} is present in highest concentration in liver, pancreas, and kidney. About one-third of the injected dose was present in the liver.

Experiments involving the X-irradiation of the exteriorized intestine of rats injected with Fe^{59} indicated that intestinal hemorrhage occurred principally on the sixth day following irradiation and is a direct effect of damage to the intestine.

A tumor was found in the thyroid gland of a six-year-old ewe maintained since conception on I^{131} at a feeding level of 5 $\mu c/g$.

Malignant squamous cell carcinomas were found in two out of 17 mouse lungs examined 400 days after intratracheal injection of 0.06 μc Pu^{239}. About 12 per cent of the original dose of plutonium was retained in these animals at sacrifice, nearly half of this being present in the lung.

Dosimetry difficulties encountered in the relative biological effectiveness work were traced to the presence of iron contamination in the P^{32} and S^{35} solutions obtained from Oak Ridge.

Barley was grown in vessels containing organic resins as carriers for essential ions, the amount of calcium being held constant while the amount of strontium was varied. The accumulation of calcium in the leaf was not affected by the variation in strontium concentration on the resin. Accumulation of strontium in the leaf increased with increasing strontium concentration on the resin at a greater than proportional rate.

5. Technical and Other Services

A record total of 1191 tests were performed by the Radiographic Testing Operation this month. These included x-ray examination, dye penetrant testing, eddy current testing, visual and dimensional checks, and ultrasonic thickness measurements.

The question of whether IBM-702 processing of document inventories yields sufficient benefit in added security to justify the high expenses incurred is now under critical review.

Analyses of water samples from two Redox wells indicated the first Sr^{90} ever to be detected in ground water at HAPO. This is primarily of historical interest and constitutes no significant radiological hazard.

There were no cases of plutonium deposition confirmed during the month. The total cases on record for the plant remained at 200.

The Home Area assignment and Roving Badge system was initiated on April 15, 1957. The inherent benefits in this system, when adopted on a full-scale basis, will be a reduction in personnel required for badge processing and increased accuracy in cumulative exposure records. The conversion of the entire plant to the new plastic badge was completed during April.

Terrestrial animals contained, in general, about the same contamination as one year ago. River samples (waterfowl) were from two to five times higher than a year ago.

River organisms were exposed for eight hours to effluent collected from a reactor tube which contained a ruptured fuel element. The activity density of algae was increased about 2.5-fold due to rupture radioisotopes, but there was little or no increase in the activity densities of small fish.

6. Supporting Functions

Personnel and overtime portions of the Budget for FY 1959 and Revision for FY 1958 for the Level 3 components were submitted during April. Also submitted was a summary schedule, at Level 2, which shows the costs to be incurred and the distribution of these costs to end functions. Detailed budgets for Level 3 components are in process but cannot be completed until firm figures have been established for the volume of Research and Development and Process Technology to be performed by HLO for the Product Departments.

General Electric Annual Reports for 1956 were delivered to all employees and annual statements of participation were delivered to those employees participating in the Savings and Stock Bonus Plan.

Employee Compensation Services, Schenectady, was furnished with salary data for each exempt employee on April 15, 1957.

Work with the Traveling Auditors was completed April 10, 1957. Formal report of their findings has been received and all recommendations adopted except the one proposing recording of exempt absences on a half-day basis.

A new method of constructing confidence interval estimates of K_∞ based on PCTR data was derived. The method is based on simultaneous confidence region estimation of both parameters in a linear function relationship between two cadmium ratios, and is a marked improvement over all previously suggested procedures.

Considerable statistical effort is being devoted to the establishment of an operating bulk outlet temperature for a given reactor such that the probability of exceeding a specified limiting temperature is remote.

On April 30 the staff of the Hanford Laboratories Operation totaled 1167, including 477 exempt and 690 non-exempt personnel. Of the total exempt employees there were 414 with college degrees, including 398 Technical degrees as follows:

BS	MS	PhD
200	101	97

Plans were laid during the month of April for the 10-week summer program for Radiological Physics Fellows. This program will commence June 24.

Fifteen suggestions were received and 10 were adopted during the month. A total of $1585 was awarded for the 10 adopted suggestions. Savings represented $25,119.33.

A slight increase in Benefit Plan participation was noted during the month.

Regional Monitor negotiations are continuing as are discussions concerning the Wonacott arbitration case. The outlook for settlement for these two cases is not clear.

No decision has yet been handed down by the Superior Court in the laundry arbitration case.

Two grievances were received during April with one being settled satisfactorily at Step One. In the second case the Step Two answer has been given.

During April, Laboratories personnel worked a total of 198,009 hours with no disabling injuries. Since September 1, 1956 a total of 1,507,098 hours have been completed with no disabling injuries. There were 40 medical treatment injuries with a frequency of 2.02 as compared to 1.98 for the previous month. The frequency to date for the year is 1.81.

There were four incidents involving calls on the fire department. Of these only one resulted in loss, that being a spontaneous fire in a barrel of uranium turnings. The estimated loss was $500.

Eleven security violation incidents were processed making the 1957 total 40 to date.

F W. Albaugh

Acting Manager
HANFORD LABORATORIES

FW Albaugh:lt

REACTOR AND FUELS RESEARCH AND DEVELOPMENT OPERATION

TECHNICAL ACTIVITIES

A. FISSIONABLE MATERIALS - 2000 PROGRAM

1. METALLURGY PROGRAM

Corrosion Studies

In-Reactor Corrosion of M-388 Aluminum Alloy. Four tubes of a production test to compare M-388 and 1245 aluminum alloys were discharged during April. During operation the outlet temperature varied from 90 to 100 C, and the total exposure was 900 MWD/T. As expected from these high temperatures and exposures, considerable uniform corrosion occurred. Preliminary information indicates that the uniform corrosion of Slug No. 4 from the rear face corresponded to a total loss or penetration of approximately 11 mils of aluminum.

None of the slugs ruptured due to corrosion, although one of the pieces had cracked as a result of failure of the uranium. Furthermore, the end slug (downstream) in each of the four tubes exhibited non-uniform corrosion as evidenced by large pits in the aluminum jackets. These pits were wide (ratio of width/depth was large) with smooth, sloping walls. A preliminary conclusion from the examination is that this non-uniform attack was at least partly a result of erosion or other form of mechanical damage. These pieces are being delivered to Radiometallurgy for further examination to determine the nature of this attack.

In each case the last slug was jacketed with M-388, so it was impossible to compare the behavior of M-388 and 1245 under identical conditions. However, in previous exposures in the reactors at high temperatures, this non-uniform attack has been noted on end slugs clad in 1245 alloy. Additional tests in the laboratory and in the reactor are being planned to determine the relative susceptibilities of these two alloys to this form of attack.

Corrosion of A203X Aluminum Alloy. The corrosion resistance of A203X alloy (5.5 wt % Ni, 0.3% Fe, 0.2% Ti) continues to be superior to alloys previously tested. The rate of corrosion at 370 C in a static autoclave is about 1/8 that of M-388 alloy at the same temperature; i.e., about 0.5 mil/year compared with four mils/year for M-388. In addition, the alloy is not subject to rapid local corrosion (e.g., intergranular attack) which has been noticed with M-388 and M-400 samples at 370 C in this test. Also, from examination of preliminary tests at lower temperatures, the temperature dependence for corrosion of alloy A203X is unusually low.

Corrosion of Uranium in Organic Coolants. The reaction between uranium and organic coolants to form uranium carbide is relatively slow, and it appears that it will not limit reactor operation. The chief variables in this reaction are time, temperature, and hydrogen pressure.

Corrosion of Zirconium in Organic Coolants. The reaction of zirconium with organic coolants to form zirconium hydride is also controlled by time, temperature, and hydrogen pressure. The reaction is rapid enough to limit or prohibit the use of zirconium or Zircaloy to contain organic coolants in power reactors.

Aluminum Corrosion Inhibition. A series of 64 experiments was completed in which coupons of 1245 aluminum were exposed to solutions containing phosphate ions (0, 0.5, 2, and 10 ppm) and dichromate ions (0, 0.5, 2, and 10 ppm) at pH 4, 5, 6, and 7. Exposure was for 308 hours at 92 C under conditions of low flow.

The addition of 10 ppm phosphate ions in high purity water inhibits the uniform corrosion of aluminum in the presence of up to two ppm of dichromate ions. With 10 ppm of dichromate present, the phosphate inhibition was not observed.

Radiometallurgy Examinations

Examination of Production Test 105-3N, Supplement A. The uncanning and testing of uranium tensile samples irradiated to an estimated 1000 MWD/T according to PT-105-3N-A has been started. The eight samples which have been uncanned to date show a slight increase in length (approximately 11 mils). Tensile test results made with the irradiated material showed it to be brittle with yield strengths higher than that for unirradiated metal. Considerable ductility was restored by annealing a 1000 MWD/T sample at 800 C for ten hours. A very low heating and cooling rate of 10 C/hour was used in going from a high alpha region temperature (600 C) to 800 C and again when cooling. The slowness of the rate of cooling through the transformation temperatures is believed to be the cause of the increased ductility.

A slow cooling rate was not required to improve the ductility of three samples from the lowest exposure (150 MWD/T) which were tested after annealing at 400 C and 600 C.

Organic Corrosion Studies. Equipment for measuring the corrosion rate of irradiated uranium in organic reactor coolants has been installed in a multicurie cell and "cold" shakedown runs are in progress.

Fuel Element Test Reactor

The test conditions to support the Hanford fuel element development program have been revised. In this revision the Hanford testing requirements are estimated to be 28 to 56 tubes, with peak thermal neutron flux densities in the fuel ranging from 5×10^{13} to 2.5×10^{14} neutrons/cm^2 sec, and 30 to 60 tubes with peak thermal neutron flux densities in the fuel ranging from 3 to 5×10^{13} neutrons/cm^2 sec. The useful length of test space in each tube should be five feet in which the flux variation is less than 15%. Both horizontally and vertically oriented tubes will still be required. The revision of Hanford test conditions will be included in the FETR report which is being prepared for publication.

Basic Metallurgy Studies

Optical and Electron Microscopy Studies of Irradiated Metals. Observation and interpretation of the damage introduced in fissionable and non-fissionable metals by neutron irradiation are of great fundamental interest in that such information is essential in the establishment of the damage mechanisms. Optical and electron microscopy are valuable tools in such studies in detecting differences occurring within grains or at grain boundaries by comparison before and after irradiation. Specimens of uranium which were etched and precharacterized prior to irradiation have been replicated after irradiation, and such replicas are being carefully examined. Very limited microstructural changes are evident from an optical standpoint, but definite evidence of the presence of two types of cracks in a specimen irradiated to 0.03 a/o burnup has been found by electron microscope examination. The cracks are either long and narrow or appear as short, discontinuous segments which have no apparent crystallographic relationships since they pass through twins and grain boundaries. Small voids and mounds have been detected at grain and twin boundaries and offer evidence that agglomeration of impurities has occurred at these sites. Additional examination of the replicas of three uranium specimens irradiated to burnups of 0.03, 0.07, and 0.10, respectively, are continuing.

Hanford Irradiation - PT-3NA. The design of advanced fuel elements depends on knowledge of the effect of irradiation on the significant mechanical and physical properties. An extensive program to obtain the necessary data for uranium is under way. Room temperature tensile properties were determined for a number of irradiated uranium samples exposed at HAPO to burnups as high as 0.10 a/o of total atoms in the as-irradiated and irradiated-annealed condition. Samples exposed to 0.10 a/o burnup (1000 MWD/T) at approximately 150 C were decanned and examined. The surfaces of these samples were not appreciably rougher or more distorted than samples exposed to 0.075 a/o burnup. The ends of the samples, however, were dish-shaped and center-drill holes in the ends appeared to have closed somewhat. Tests of three samples yielded the following average values: ultimate strength, 77,400 psi; 0.2 per cent yield strength, 73,400 psi; elongation in one inch, 0.55 per cent. These values are nearly the same as those for specimens exposed to 0.03 and 0.075 a/o burnup, indicating that the damage is essentially saturated at low exposure levels. One of the samples exposed to 0.10 a/o burnup was annealed at 800 C for 10 hours with controlled heating and cooling rates. Previous gamma phase anneals had introduced cracks in samples exposed to 0.075 a/o burnup. The sample was heated from 600 C to 800 C at 10 C/hour and cooled from 800 C to 450 C at 10 C/hour. The room temperature tensile properties were: ultimate strength, 32,200 psi; 0.2 per cent yield strength, 29,100 psi; and elongation in one inch, 4.6 per cent. The slow heating and cooling through the transformations evidently minimized the effects of transformation stresses and resulted in material with appreciable ductility. A pronounced cleavage failure prompted the replication of the fracture surface. A sample exposed to 0.075 a/o burnup was given the same annealing treatment and the resulting properties were: ultimate strength, 36,100 psi; 0.2 per cent yield strength, 17,300 psi; and elongation in one inch, 12.4 per cent; confirming the effects of heating and cooling rates.

Three samples exposed to 0.018 a/o burnup were annealed 10 hours at 400 C, 25 hours at 400 C, and 10 hours at 600 C. Annealing at 400 C reduced the yield strength to pre-irradiation values but caused very little change in elongation. The values were 75,000 and 76,000 psi ultimate strength; 39,200 and 39,200 psi, 0.2 per cent yield strength; and 2.5 and 2.6 per cent elongation for the 10 and 25-hour anneals, respectively. Annealing for 10 hours at 600 C resulted in ultimate strength of 84,500 psi, 0.2 per cent yield strength of 35,200 psi, and elongation of 5.7 per cent. This recovery of ductility in addition to the results of gamma phase annealing is the first indication that the process responsible for embrittlement can be relieved.

Irradiation of Zircaloy-2 Tensile Specimens. Mechanical property data on irradiated specimens of projected structural metals are necessary in establishing optimum tube dimensions. With this in mind, several structural materials have been irradiated. Room temperature tensile properties were determined for annealed Zircaloy-2 specimens exposed in the MTR to 1.4×10^{20} nvt (> 1 Mev) and 7×10^{20} nvt thermal after post-irradiation anneals at 400 C. The values obtained for yield strength indicate that 62 per cent of the radiation hardening is removed in 10 hours at 400 C and that 89 per cent is removed in 100 hours at 400 C. These data, in addition to those from previous anneals at 250, 300, and 350 C, show the temperature range for recovery and provide limited knowledge of the time dependence of the recovery process.

Diffusion of Uranium. A knowledge of the interdiffusion of uranium and current and projected clad and barrier metals as functions of time and temperature is essential in the design of fuel elements. Extensive studies are in progress to obtain the necessary information. An evaluation of the literature on U-Ni-Al diffusion is nearly complete. Most of the data have been obtained in conjunction with hot-press canning studies, and therefore, short times, high pressures, and high temperatures were applied during the diffusion anneals. Data found in SEP-211 indicated, however, that the total Ni/Al diffusion zone thickness, after 40 hours at 400 C (752 F) under atmospheric pressure, would be 0.014 mm. A report summarizing and evaluating the available data is being written.

New Fuel Element Development

Seven-Rod Cluster Fuel Element Irradiation Test. A basket assembly containing three seven-rod cluster fuel elements was charged into a KE through-hole facility on March 1, 1957, under Production Test 1 P-46-A. This test is part of a program to develop a fuel element capable of performing satisfactorily at higher operating temperatures, higher specific powers, and higher burnups than present Hanford fuel elements. To date, this basket assembly has received approximately 400 MWD/T exposure and is currently operating successfully at 60 kw/ft. It is estimated that this assembly will be discharged in the early part of May after sustaining a burnup of 600 MWD/T.

Seven-Rod Cluster Fuel Element Flow Blockage Studies. In order to predict the results of a rod failure in a seven-rod cluster fuel element and to test the integrity of the supporting spider design, a series of three tests

was completed this month. Three different seven-rod cluster fuel elements containing one, two, and three purposely defected rods, respectively, were exposed to 280 C water in the Elmo-4 Loop Facility at 100-H Area. In all cases the spider support withstood the stresses imparted to them by the swelling rods. Coolant flow was reduced by 8.27 per cent, 23.4 per cent, and 49.7 per cent in failing one, two, and three rods, respectively. In the case of a three-rod failure the fuel element required 3500 pounds of force in order to discharge the fuel element. No damage was inflicted to the section of KER-size tube in which the fuel element was failed. The other two fuel elements discharged easily. The probability of more than one rod failing in a single fuel element is very remote; however, it is impossible at this time to predict the number of rods which might fail due to the stresses imparted and the heat liberated by a single defected rod under conditions of irradiation.

Fuel Elements for Organic Coolant. Experimental work in support of the production of test fuel elements for organic coolant is aimed at the problems of can material choice, diffusion of hydrogen through the jacket, creep strength of jacket material, pre-coating the uranium and canning methods. Simulated fuel elements produced by sizing uranium rods into brass, aluminum, magnesium, and mild steel cans with welded closures were autoclave-tested in MIPB at 380 C. The pressure in the autoclave was held below 200 psi by periodic bleeding. Preliminary data indicate that exposures of one to four weeks in the autoclave causes a measurable increase in the hydrogen content of uranium clad in any of the four materials. These data will be checked with duplicate tests. After 117 hours in the autoclave the magnesium clad element showed a local thickening of the can wall at a position corresponding to the end of the uranium cylinder. This upsetting of the can wall was ascribed to the difference in thermal expansion between uranium and magnesium. The British were able to prevent a similar ratcheting effect on their magnox clad elements by mechanical bonding of the magnesium alloy can to the uranium. Aluminum clad uranium bumped on the surface as a result of diffusion between the uranium and aluminum after 500 hours exposure at 400 C. The ratcheting effect was barely observable on the brass can after 787 hours exposure and, after stripping the can, diffusion between the brass and uranium was evident. The iron can was apparently unaffected by exposure for 787 hours. A similar set of test fuel elements in cladding an aluminum jacketed Al-Si bonded piece was charged into the ORA-1 loop for exposure to recirculating MIPB at 300 to 350 C. Pre-coating the uranium with a metal or intermetallic compound may be used to retard diffusion between uranium and an aluminum can; to bond the uranium to a magnesium can; to prevent hydrogen diffusion; or it may be used to protect the uranium from oxidation during a high temperature canning process. Metals that are soluble in molten magnesium may be diffusion-coated onto uranium by dipping uranium into magnesium containing the dissolved coating metal. This technique is being investigated as a means of coating uranium with aluminum or zirconium prior to canning in aluminum. Sub-size magnesium cans were made by direct extrusion of magnesium over a steel mandrel. This work was done to determine the feasibility of direct extrusion of magnesium cans over uranium fuel pieces.

I & E Wafer Element. The internally and externally cooled wafer element is of interest for present and future HAPO reactor application because the increased surface area permits higher power operation and the wafer

feature provides failure safety in a hot water environment. The examination of a specimen of this design that was irradiated in the MTR had proceeded to the point of metallographic study of a wafer from the element when breakdown of cell facilities in Radiometallurgy caused a delay which continued to the end of the reporting period.

Insulated Uranium Fuel Elements. Insulated fuel elements in which the uranium fuel operates at high surface and central temperatures may prove to be resistant to thermal stress failure. The uranium in such fuel elements also operates at temperatures which simulate the operating temperatures of fuel in a high temperature coolant. Three cored insulated elements have completed an irradiation in KW-3674 through-hole at a power of about 50 kw/ft and an exposure of about 700 MWD/T. These fuel elements will be subjected to post-irradiation examination at the C Basin facility and the HAPO Radiometallurgy facility. A document proposing the irradiation testing of solid insulated uranium fuel elements in a K through-hole facility is being issued. This proposed irradiation will be a follow-up of the irradiation testing of cored insulated uranium fuel elements. The solid fuel elements will operate at 53 kw/ft with a uranium surface temperature of about 425 C and a maximum central temperature of about 850 C; thus, experience will be gained with multi-phase operation of uranium. No operating hazard is foreseen with the solid insulated fuel elements in a K through-hole facility.

Coaxial Fuel Element. Coaxial fuel elements are of interest for HAPO reactor application because they offer promise of having the increased split failure resistance of the larger inner diameter cored element without the accompanying reactivity deficiency. The examination of a specimen of this design that was irradiated in the MTR has been held up by mechanical breakdown in the Radiometallurgy facility.

Thermal Stresses in Cylindrical Elements. A method of calculating the thermal stresses and strains in cylindrical reactor fuel elements, which utilizes a very general material model, has been formulated and described in previous documents of this series. Numerical calculations using this method are now being run on the IBM 650 Digital Computer. Last month calculations for a cored fuel element operating at two different power levels were completed. In one case the maximum power generation was 50 kw/ft for a cored fuel element with a uranium surface temperature of 200 C and a inner-to-outer diameter ratio of 0.4. For this case the maximum strain occurring after a half-hour period of power increase was at the outer surface and was 0.527 per cent. The strain at the inner surface was 0.467 per cent. For a similar case, with the maximum power generation at 76.8 kw/ft, the maximum strain occurring after a half-hour period of power increase was at the inner surface and was 1.16 per cent while the strain at the outer surface was 0.72 per cent. The complete stress and strain distributions have been obtained for the half-hour period of power increase and a half-hour period at constant power. Calculations are now being made on the internally and externally cooled fuel elements.

Buckling of Vertical Fuel Rods. An investigation of the mechanical factors contributing to the buckling of long vertical fuel rods has been initiated. Only elastic buckling calculations have been made; hence, the high

temperature effects of creep have not been investigated as yet. A proof of the fact that pure hydrostatic pressure will not cause buckling was obtained. A general formulation of an energy method for the collapse of columns under their own weight was obtained. Two term calculations for the collapse weights or critical lengths of straight columns under their own weight were completed. These calculations gave the following results:

Simply Supported Column

$$\frac{ql^3}{EI} = 0.94\ (2\pi^2)$$

Built-in Column

$$\frac{ql^3}{EI} = 0.947\ (8\pi^2)$$

where l = length of column, q = weight per unit length, E = elastic modulus, and I = second moment of inertia.

Calculations have been started for determining the effects of initial displacements and forces normal to the column.

Fuel Element Design Handbook. Preparation of a handbook of fuel element design by members of Fuels Development Operation and Plutonium Metallurgy Operation is under way. The handbook will contain pertinent data and methods of fuel design so that it may be useful to reactor and fuel element design personnel and serve as an educational tool for inexperienced personnel. It is planned that the handbook will be ready for publication by July 1, and that it will be published in a form such that revisions and additions can be made with a minimum of effort. The outline is complete and all writing assignments have been made.

KER Size Wafer I & E Fuel Elements. The dip-canned wafer I & E fuel element design has been selected as a candidate for initial KER Loop operation. Sixteen of these elements have been fabricated in 306 Building through the welding stage. They are now being tested for quality upon completion of which they will be turned over to FPD who will arrange for reactor testing.

Cold Closure Fuel Elements. The fabrication of fuel elements for an in-reactor test of the cold canning process has begun. These elements will be unbonded and will utilize a thin nickel coat for a diffusion barrier between the core and jacket. Fabrication and inspection will be completed during May.

Fusion Welding in a High Vacuum. A welding process which makes possible controlled fusion welding in a high vacuum is now being developed. This process utilizes a concentrated bombarding beam of electrons in a vacuum of 5×10^{-4} mm of mercury, or better, to heat the parts to be welded. The results of evaluation of welds made with this process on Zircaloy-2 materials were: tensile strength and ductility approximately the same

as the as-received material, and the hardness in the fusion area is the same as of the annealed base material. The evaluation indicates that this process is satisfactory for the production of welds of the highest quality on Zircaloy-2 material.

Welding Stainless Steel Jacketed Fuel Elements. A requirement for fusion welding 0.007-inch wall, 5/8-inch diameter stainless steel fuel element jackets to heavy stainless steel end caps has arisen in the development of cluster fuel elements. A suitable joint design combined with a special jig unit using the tungsten inert arc process has resulted in a method of welding this joint which yields a closure of excellent quality. Evaluation of the mechanical properties and the study of photomicrographs of the weld area indicates that this procedure is suitable for the high quality welding required on fuel element closures. A check of weld quality under semi-production operating conditions resulted in consistently high quality closures with no problems in producing uniform welds. This procedure is suitable for fuel element closures.

Roto-Arc Welding. Design and fabrication of an improved gas shield and magnetic flux concentrator for the Roto-Arc machine have been completed. A more complete and versatile control panel has been installed to meet the needs of the present unit as well as the more elaborate welding unit now under construction. The recently designed unit will be employed in the welding of the small end of the I & E fuel elements.

Evaluation. The investigations of the metallurgical quality of the 192 Sylvania hot-pressed, vacuum canned I & E fuel elements received from Sylvania Electric Products Corporation in February was completed the latter part of April. Approximately 30 per cent of the Sylvania fuel elements failed to meet the specifications which are placed upon the Hanford fuel elements, due chiefly to over-etched surface condition and closure quality.

2. REACTOR PROGRAM

Coolant Systems Development

Single Pass Coolant Development. Visual examination was made of M-388 and 1245 aluminum alloy clad fuel elements following exposure in H Reactor to 850 to 900 MWD/T. Four tubes containing slugs with both types of jackets were discharged on April 7 following 152 days operation with normal process water. The highest power tube averaged 100 C outlet temperature. Out of six slugs examined, four M-388 slugs showed moderate to severe localized corrosion attack; two 1245 jacketed slugs showed no unusual attack. Three of the four M-388 pieces examined were the last slug downstream. These observations are very preliminary and complete examination of the remaining discharged slugs is in progress.

KER Activities. The three KER water loops were placed in in-reactor recirculatory operation using dummy fuel loadings. Replacement of a canned motor pump on the K-3 loop was effected following a bearing failure. Water quality in the loops is being monitored carefully to assure satisfactory test conditions following active metal fuel loadings early in May.

Conversion of the K-1 loop for organic coolant testing continued. Design of the vacuum distillation apparatus and degasifier was completed and fabrication was begun.

Rupture Simulation Tests. Five simulated rupture tests were performed using candidate KER fuel elements. Three seven-rod clusters were run at 280 C; the clusters had one, two, and three rods, respectively, defected by drilling a small hole in the jacket. Two Elephant slugs were tested at temperatures of 160 and 200 C for periods up to 50 hours. In general, all simulated rupture tests to date indicate that ruptures in KER, if they do occur, will not result in serious flow decreases or tube damage due to expansion of the failed elements.

Aluminum Corrosion Studies. Recent data from the aluminum corrosion program have resulted in a shift in emphasis in the testing conditions. Long term ELMO-loop data at pH 3.5 indicate that stainless steel may be attacked intergranularly at moderate temperatures. Also, ANL studies have shown superior aluminum corrosion results at pH 4.5, with added phosphate ion. For these reasons, tests at pH 3.5 are being discontinued.

Organic Coolant Technology. An eutectic mixture of two terphenyl isomers plus biphenyl has been investigated for the next in-reactor test. Present data indicate that a mixture freezing below room temperature is obtainable. These compounds are potentially useful at temperatures well above those of MIPB, where the limitations arise from thermal decomposition temperature thresholds or radiolytic decomposition rates.

The out-of-reactor loop ORA-1 has been turned over to Coolant Testing Operation for routine operation. Initial tests were conducted at 300 C since operating difficulties prevented extended testing at the scheduled 350 C temperature. Laboratory tests have determined the rate of thermal decomposition of MIPB at temperatures between 375 and 450 C. The decomposition rate at 430 C appears to be in the same range as the radiolytic decomposition rate (1-2 per cent per hour) for a flux of 3×10^{13} nvt.

Thermal Hydraulic Studies

Single Tube Flow Anomaly Studies. Further experiments were completed which comprised simulating the response of a process tube system to abnormal flow conditions. These tests will serve to prove the feasibility of higher reactor power levels from the standpoint of hazards to individual tubes due to inadequate flow. Comprehensive data were obtained for B-D-F process tube geometry for cases of flow instability reached by (1) slow tube plugging, (2) power excursions, and (3) fast tube plugging. Analysis of test results is 50 per cent complete.

Two-Phase Flow Studies. Experiments were performed to investigate critical flow conditions in the piping connecting the reactor process tubes to the rear cross-headers. When critical flow conditions exist, the flow through a process tube is independent of rear cross-header pressure below particular values of rear cross-header pressure. It was

found, for example, that for 110 C outlet water temperature critical flow would exist in a B-D-F type process tube at a CG-558 central zone flow rate for all values of rear cross-header pressure below 50 psig.

Slug Core Temperature. Analytical work was completed and a report issued concerning the temperature gradients in the core of a slug for various values of thermal resistance to the end cap. It was shown that the increased heat generation near the end caps due to the Wilkins effect need be considered in calculating maximum uranium temperatures only when there is a high thermal resistance between the uranium and the end cap.

Irradiation Test Engineering

Attenuation Characteristics of Ordinary Concrete. The determination of the attenuation characteristics of ordinary concrete was started with the insertion of test slabs in the far test well at DR reactor.

Neutron Dosimeter. A second BF_3 tube was calibrated for the paraffin-moderated neutron dosimeter with plateaus plotted for high voltage and discriminator level.

Mechanical Equipment Development

The storage tank-pressurizing vessel for the Mechanical Organic Test System (MOTS-1) was inspected by a representative of the Travelers Insurance Company and approved as meeting the ASME Unfired Pressure Vessel Code.

Nonmetallic Materials Development

High Temperature Graphite Irradiation. Samples of reactor grade graphites were discharged from the ambient temperature irradiation facility in C reactor after an exposure of 3024 MD/AT at an average temperature of 525 C. Length measurements were completed on all the samples. A comparison of radiation distortion at this temperature with previous distortion data at 400 C shows no significant difference in radiation effects. Different grades of graphite varied, however, according to both coke material and graphitization process.

All graphites showed the expected contraction in the parallel direction. A slight expansion occurred in transverse KC, a well ordered coke with graphitization at 2800 C, and in CSGBF, another good coke, but with graphitization at 2450 C. However, Cleves coke (CS-AGOT-F) graphitized at 2800 C had contracted slightly at this exposure which was unexpected in view of the higher graphitization temperature.

Property Changes of Impervious Graphite in Organic Coolant. The possibility of passing reactor organic coolant directly through graphite tubes is being explored. Two samples of milti-impregnated impervious graphite and four samples of reactor grade graphite were charged into the out-of-reactor loop at 1706-KE charged with MIPB. Weight and size of the samples were measured to test for absorption of organic and its possible effect on physical dimensions.

Irradiation Annealing of Graphite. Tests of a possible cause of irradiation annealing have shown that cyclic temperature changes encountered in reactor operation cannot account for the additional annealing of radiation damaged graphite. A graphite sample irradiated in a cooled test-hole was annealed for 2-1/2 hours at 400 C; the temperature was then cycled between 100 C and 395 C with a 30-minute period for 18 hours. No additional annealing to sample length or crystallite parameters was observed from the cyclic temperature treatment. From this test it is concluded that a cyclic variation of temperature in the absence of a neutron flux is not responsible for the irradiation annealing phenomenon.

Irradiation of Candidate Organic Coolants. Three sets of three quartz ampoules containing biphenyl, monomethyl biphenyl, and monoisopropyl biphenyl have been prepared and sealed into aluminum sample containers. These containers will be charged in the near future into the Snout II test hole at KW reactor. Each set of three ampoules will be exposed for an eight-hour period during equilibrium operation. By varying the mass of the central aluminum core of the sample containers, gamma heating will effect a different exposure temperature for each set of ampoules and will allow a comparison of the radiation stability of the three aforementioned organic compounds as a function of temperature. The three exposure temperatures, which will be continuously recorded, were estimated by heat transfer calculations to be about 400, 430, and 460 C.

Fabrication of Base Metal Thermocouples. Simple techniques have been developed for arc-welding and gas welding iron constantan and other base metal thermocouples. Unless special precautions are taken in the case of iron-constantan couples, the constantan wire (m.p. 1280 C) rapidly melts away from the iron wire (m.p. 1535 C) and does not form a good weld. A report, HW-49815, "Notes on the Fabrication of Base Metal Thermocouples," will be issued which describes the apparatus and methods recommended for the preparation of iron-constantan and chromel-alumel thermocouples.

Structural Materials Development

B-D-F Size Zircaloy Process Tubes. Recent developments have demonstrated that greater care must be exercised in the design of tube reducing machine mandrels for the fabrication of ribbed Zircaloy tubing than is normally exercised in the design of mandrels for the fabrication of plain tubing. It has been shown by both Allegheny Ludlum Steel Corporation and Superior Tube Company that if the tube wall is reduced more than the rib during the tube reducing operation the rib will be pulled apart resulting in a series of fractures along the length of the tube. Examination of tube reducing mandrels by both companies has revealed that along the tapered, working portion of the mandrel unequal amounts of reduction were being taken in the wall and in the ribs even though the final tube dimensions indicated equal reductions of the wall and the ribs. Allegheny encountered no apparent difficulties from this source during three successive reductions of 40 per cent; however, during the final reduction of 52 per cent to 56 per cent cracks appeared in the ribs. These cracks were formed in a region where the reduction of the wall was twice that of the ribs.

Both companies are actively pursuing a program to eliminate these tool design difficulties. The Superior Tube Company has completed a new mandrel design and placed an order for the fabrication of the new mandrels with the Ruesch Machine Company. A delivery date of May 21 is promised; however, Superior will endeavor to improve this schedule. The new mandrels will require slight changes in the extruded tube blank, and the new extrusions have been ordered by Superior from the Chase Brass Company. These extrusions will also incorporate an external rib to provide a uniform wall thickness around the circumference. Allegheny Ludlum in cooperation with Tube Reducing Corporation has completed a detailed redesign of their tube reducing mandrel and it is being fabricated by the Tube Reducing Corporation. Estimated completion date for the new mandrel is May 1, and tube reducing trials are scheduled for May 4.

Delivery of all items necessary for the modification of the tube reducing machine by the Superior Tube Company were scheduled for delivery by April 19. It is currently planned to proceed with the modification of this machine in the near future. A recent modification to a tube reducing machine by the Tube Reducing Corporation now makes it possible to tube reduce 25 to 26-foot starting blanks. This increased length of starting blank will permit a decrease in the final reduction of area from approximately 54 per cent to 45 per cent. However, to take advantage of the increase in length of the starting blank will require modification of the extrusion blank size, and of the tube reducing tooling.

IPR Type Zircaloy Process Tubes. It has been clearly demonstrated that there exists a limit to the amount of cold work to which Zircaloy-2 or 3 can be subjected without material failure. The value of this limit can only be approximated from the work performed to date. Because the magnitude of this value will determine the extent of tube reducing machine modification required to produce 50 feet of reactor process tubing, it is essential that it be determined accurately. Contract DDR-11 was designed to establish these limits of cold work for Zircaloy-2 process tubing of a size and wall thickness typical of that to be used for an IPR. This limit will be determined for both ribbed tube and ribless tube geometries. Work under this contract (DDR-11) at Allegheny was begun in April. The ingots provided by General Electric were hot forged and rolled to billet diameter for subsequent extrusion into tube blanks. The design of tube reducing tooling will be based upon the latest developments from DDR-5 and 6, and tube reducing experiments are expected to start early in June.

Aluminum Lined, Zircaloy Process Tubes. The use of aluminum lined Zircaloy process tubes to contain high temperature organic coolants may have advantages over a solid aluminum tube. An experiment has been initiated to establish some of the areas which require detailed study before the feasibility of the fabrication and use of such tubes can be demonstrated. The initial tests include studies of the dimensional behavior of unbonded aluminum lined Zircaloy-2 tubes during thermal cycling, and a qualitative study of the diffusion characteristics of aluminum and Zircaloy-2.

First results were obtained with three-inch long, 1/2-inch diameter, unbonded, aluminum-lined, Zircaloy-2 tubes with the tube ends restrained to prevent only the differential thermal expansion expected during heating. These results indicate that the aluminum tube material is "upset" (e.g., shortened with thickening of the wall) during heating. This causes a decrease in both length and diameter dimensions upon cooling by an amount that corresponds to the theoretically predicted change of dimensions within the limits of experimental error. The study is continuing, to determine the behavior of aluminum lined tubes with the ends restrained against both expansion and contraction.

B. WEAPONS - 3000 PROGRAM

Research and development in the field of plutonium metallurgy continued in support of Hanford 234-5 Building Operations and weapons development programs of the University of California Radiation Laboratory (Project Whitney). Details of these activities are reported separately via distribution lists appropriate to weapons development work.

C. REACTOR DEVELOPMENT - 4000 PROGRAM

1. PLUTONIUM RECYCLE PROGRAM

Plutonium Fuels

The plutonium-bearing fuel elements and flux monitoring discs for the PRP reactor tests in the PCTR were completed and sent to the 300 Area. The fuel rod cores were vacuum cast, 5/8" diameter and 11" long, and machined to final size. Some concern was expressed about the amount of plutonium segregation which may have taken place in the rods, so samples were taken from the tops and bottoms of the 84 rods and submitted to the Radiochemical Analytical Laboratory. The results of the radioassay analysis of the 164 samples were submitted to the Operation Research and Synthesis unit for statistical analysis. By analysis of variance techniques it was determined that there was significant difference between the ends; however, the difference reported (.035) is only a two per cent variation from the 1.79 w/o Pu average. This amount of segregation does not appear serious, but the problem may become more acute when castings are made in large sections and with higher Pu concentrations.

Plutonium alloyed with pure aluminum is presently planned as the plutonium-containing fuel material for the demonstration reactor; however, this material is not expected to have the best possible corrosion resistance in 250° water. The Corrosion and Coatings Operation is testing a number of candidate alloys using uranium as a standin for plutonium. One material that will be tested is an alloy of Al-12 w/o silicon - 2.0 w/o U.

Aluminum-silicon alloys appear to have better corrosion resistant properties in 250 C water than plutonium alloys containing just pure aluminum. However, little is known about the workability of these alloys. Plutonium radioactivity precludes any formability studies without properly enclosed

equipment. Since this equipment is not available at the present time, aluminum-silicon-uranium alloys will be used as standins for aluminum-silicon-plutonium alloys.

Aluminum-uranium and aluminum-plutonium alloys (containing less than 20 a/o uranium or plutonium) form isomorphous intermetallics UAl_4 and $PuAl_4$, respectively. Therefore, it is concluded that the working characteristics of these alloys will be similar. Aluminum alloys containing up to 15 w/o plutonium are of interest as possible fuel element materials

Extrusion and rolling experiments are planned for alloys composed of Al-12 w/o silicon and from 1 to 15 w/o uranium. Alloys containing four and five per cent uranium have been billeted for subsequent rolling.

The appropriation request for the 125-ton capacity extrusion press has been approved and design of the hydraulic system and power unit has been completed. All associated valves and other necessary equipment have been purchased.

All of the PCTR pieces were clad with aluminum and had welded closures except for three of the test assemblies which were clad in Zr-2. The monitoring discs were 0.010" thick fuel core wafer sections clad in 0.005" aluminum with soldered joints. Pieces which were shipped included 18 outer buffer assemblies, six end buffer assemblies, six two-piece test assemblies, and six monitoring discs. The seven closure rejects on the fuel rods were attributed to imbedded foreign material believed to be swaging lubricant in the tubing. Considerable difficulty was experienced in trying to obtain leak-free monitoring discs of the originally planned 0.020" thickness. Six leak-free discs were obtained only after the canned wafer thickness was increased to 0.030". It is believed that a cold pressure welding process would be more satisfactory for sealing such thin wafers. Investigation of this method is under way. All of the jacketed fuel rods were free of any external contamination and the monitoring discs were found to have less than 500 d/m on their surfaces.

To aid in the PRP plutonium-bearing fuel element development effort, capsules containing fuel element cores of aluminum - 1.65 w/o plutonium and aluminum - 12 w/o silicon - 1.65 w/o plutonium alloy are being prepared for irradiation in the MTR. Tentative plans are to have four capsules ready to commence irradiation in cycle 87 which begins May 13, 1957. The proposed schedule is for one capsule of each core material to be irradiated for one reactor cycle and one capsule of each core material to be irradiated for two reactor cycles. This is equivalent to approximately 25 and 50 per cent burn-up of the plutonium atoms, respectively. Heat transfer and physics calculations have been completed and if the capsules are irradiated in the GEH-3 facility in the desired effective flux of 2.9×10^{14} neutrons/sq cm/sec, the maximum core temperature is calculated to be about 350 C and the specific power generation is about 12.7 kw per cu in., which is three times the average specific power generation expected in the PRP reactor fuel elements.

The Savannah River order for fabrication of 100 Pu-Al alloy foils and pin has been completed. An analytical sample of plutonium fluoride will also be sent with this shipment to be used for a determination of the isotopic content of the plutonium. Facilities for this determination are not available at Hanford and will have to be conducted at the Knolls Atomic Power Laboratory. The Pu-Al alloy foils were canned in two-mil nickel and soft soldered around their circumference and spot welded in four places. They were then bubble tested for leaks. A technique was developed for canning these foils without the spread of alpha contamination.

The first attempt to weld the closure on the double-canned plutonium-aluminum pin was unsuccessful due to the interference of the anodized coating on the inside of the outer can. The anodized coating was more thoroughly removed on the second attempt and a satisfactory closure was made with the tungsten inert gas process. These closures were also tested for leaks with the bubble tester.

UO_2 Fuel Development

M-388 Clad, UO_2 I & E Fuel Elements (GEH-4G). Two tubular ceramic fuel elements (1.474" OD x 0.375" ID x 8.850" long) consisting of 92 per cent dense UO_2 clad in M-388, Ni-Al alloy, were fabricated without incident and shipped to the MTR for irradiation in the GEH-4 facility at a calculated power generation of 50 kw/ft. Irradiation will begin with cycle 87, starting May 13. Maximum calculated core temperature is 868 C. The principal objective of the test is to evaluate UO_2 cladding material other than Zircaloy.

Prototype PRP Fuel Element. A nineteen-rod cluster, prototype fuel element containing lead-tin pellets in stainless steel tubing was fabricated. This element was constructed on the basis of the NPD fuel design; it does not appear to be of sufficient structural integrity for use in the PRPR. The prototype fuel element was delivered to the Coolant Systems Development Operation for flow testing.

Extrusion of UO_2 Rods. Fabrication of the central rod of nested tubular fuel elements for the second PCTR loading was started, using MCW "Ceramic Grade" UO_2. Densities of the first few rods were 93-95 per cent of theoretical after sintering eight hours at 1750 C. This density was reduced to the desired 91-93 per cent by sintering for only one hour.

Pressing UO_2 Tubular Elements. Ninety-two per cent dense UO_2 pieces for loading the eight-inch, I & E fuel elements for irradiation in the MTR were fabricated by cold-pressing, sintering and grinding. Facilities were prepared for pressing the outer tube of the nested tubular fuel assembly for the PCTR loading with a 400-ton press in the 306 Building. Sufficient UO_2 was readied for pressing the inner tube of the assembly with the 50-ton press in 325 Building.

Isostatic Pressing of UO_2. Several rods and tubes were formed by compacting UO_2 powder in rubber dies at 45,000 psi. Large tubes were 3.0 inches OD x 2.50 inches ID and 11.0 inches long; small tubes were 1.50

inches OD x 1.250 inches ID and 12.50 inches long; the rods were 1.0 inch in diameter and 12.25 inches long. The ceramic bodies possessed sufficient mechanical strength to be handled without breaking. In addition to fabrication of powder, various pre-formed fuel element shapes, i.e., pellets, spheres, rods and rings, were pressed successfully at 40,000 psi in special rubber envelopes. Improved physical and mechanical properties resulted from this treatment.

UO_2 Powder Characteristics and Fabrication Behavior. Various PWR grade, ceramic grade, and oxidation-reduction treated UO_2 powders were pressed at 15, 25, 35 tsi and sintered at 1750 C for eight hours to correlate known powder characteristics with fabrication behavior. Post-sintering calculations are being completed. Studies of the microstructure of sintered UO_2 and other ceramic materials were continued in cooperation with the Physical Metallurgy Operation; an interim report of this work is being written. To provide additional information on the optimum sintering conditions for UO_2 fuel elements, temperature gradients of the firing zone in the experimental sintering furnace were determined. With the furnace control set at a sintering temperature of 1700 C, resistance measurements were made on a molybdenum resistance thermometer at various positions along the length of the firing zone. In general, the major portion of the sintering region was quite uniform in temperature, varying between 1680 and 1705 C.

Swaged UO_2 Fuel Element Design. Document HW-49567 was published. This paper describes the method and presents results of calculations of core temperatures in swage-compacted UO_2 reactor fuel elements. The described method considers the variables of void fraction, thermal conductivity of solid and gas as functions of temperature sintering of compact during operation, and power generation. Three UO_2 zirconium clad fuel elements have been made by swaging and have been equipped with spacing spiders for testing in the MTR. One of the three will be held as a reserve and display piece, the other two will be reactor tested. One piece to be tested will have an oxide density slightly better than 90 per cent of theoretical and the other approximately 85 per cent of theoretical. Four legged, sheet zirconium spiders are welded onto each end of the slug and are designed to give good alignment and support with a minimum of water flow restriction.

Small extrusion dies have been made for the high temperature (750 C) co-extrusion of UO_2 clad in Zircaloy-2. A copper sleeve will be used as a protective vacuum jacket and lubricant.

Mechanical Equipment Development

The lump sum contract for the construction of the Process Tube Test Shaft in the 314 Building was awarded to the G. C. Grant Company and construction work began on April 22.

The mechanical drawings for the PRPR Single Tube Prototype Facility were approved and the piping and equipment ordered. Specifications and drawings for the required instrumentation and control equipment have been received and comments are being submitted. Preparation of the operating manual for the facility continued.

Comments and a proposed schedule have been prepared for the seal evaluations specified in Design Test PR-50. Fabrication of the special ELMO-7 test section to test two types of proposed process tube inlet fittings continued. Planning of tests necessary to insure the reliability of the moderator level and dump control systems continued. The firm design of the calandria is expected by early May. Detailed study was given to the equipment needed and the tests to be conducted to insure proper operation of the transfer chain mechanism. At the present time three different mechanisms are under serious consideration.

Coolant Systems Development

A study was made of 300 Area water to determine its suitability for PRPR boiler make-up. Silica concentration appears to require excessive blow-down under the planned operating conditions. Demineralization of the supply and overall treatment requirements are being evaluated.

Thermal Hydraulic Studies

Detailed design has been completed of a vertical test section facility. Construction is 30 per cent complete.

Shielding Engineering

Calculations were made for shields constructed of iron-limonite concrete and laminations of steel and water. Based on a density of 270 pounds per cubic foot for iron-limonite concrete, a secondary shield constructed of this material would be 36 inches thick to give the required attenuation. A thickness of between 26 and 30 inches would give the required attenuation if the shield is constructed of steel-water laminations.

The activity of the Zircaloy-2 process tubes was calculated to determine the size cask required for safe removal of the process tubes. The 65-day Zr-95 dominates the activity for lead thickness up to four inches. For thicker shields the 2.6-hour Ni-65 dominates even though only 0.5 per cent is contained in the alloy.

Discharging fuel elements from the PRPR with about 15 minutes decay time presents some uncertainties in the activity levels calculated, since published data on fission products apply to 30 minutes decay time or longer. Recent preliminary results from Oak Ridge on short time decay showed that rough extrapolations were adequate down to ten minutes, although decays below one minute will yield significantly higher dose rates than originally calculated.

PRP Alloy Development

A billet of AlSi containing five per cent uranium has been swaged and machined to size for preparation of a Zircaloy-2 clad fuel element for corrosion testing. Tests of this unclad material have shown it to have high temperature aqueous corrosion resistance superior to the uranium-aluminum binary alloy. The dimensional changes will be observed with a

predefected clad element after a 24-hour test in 350 C water. A similar plutonium alloy will be prepared and tested if the uranium formulation proves promising.

Zirconium Tubing for PRPR

Wolverine Tube Company reported that satisfactory progress is being made on the fabrication of sheath tubes for the 19-rod cluster fuel element and the two small size tubes for the nested tubular element. Some difficulty was reported resulting from stringers of inclusions in the Zircaloy-3 ingots. No details as to the extent of this difficulty have been obtained; however, Wolverine assures us that the May 1 delivery date will be met.

The Chase Brass Company initiated fabrication of four Zircaloy-2 process tubes. The ingot was forged, turned, and cut to billet length in preparation for extrusion of tube blanks. Two of the tubes will be finished by cold drawing to size. The other two tubes will be finished by a sinking operation and grinding. The sinking operation will reduce the diameter to size but will not alter the tube wall appreciably from that obtained during extrusion. The cold drawing will reduce both the diameter and tube wall to final dimensions.

Plutonium Fuel Cycle Analyses

Recycle Evaluation. Estimated savings in nuclear power costs that may be achieved through the application of plutonium recycle were analyzed as a function of plutonium cost and jacket tubing cost. An example reactor case shows a most probable saving (50% probability) of 0.4 mil/kw-hr over the best that can be achieved with U-235 enrichment. Almost certain savings of 0.2 mil/kw-hr and a potential saving of 1.0 mil/kw-hr (50% of fuel costs) may be realized from proposed research and development.

Fuel Cycles. Using the method of equilibrium parameters, the effect of moderator temperature on the recycle period of a reactor operating on Pu recycle has been estimated. For the parameters chosen, the analysis predicts a uranium exposure of 12,500 MWD/T at 20 C decreasing linearly to 8,250 MWD/T at 400 C with a slope of -11.3 MWD/T per °C rise in moderator temperature. These results apply to a lattice characterized by $k = 1.15$, $\epsilon = 1.03$, and $f = 0.92$ at 20 C. The feed is natural uranium in a single pass. The cross sections used are those of Westcott (CRRP-680), compiled mostly from BNL-325 data for the Tripartite Nuclear Cross Sections Conference and are effective values applicable to a well-moderated thermal reactor spectrum. To make some allowance for self-shielding, the resonance integral contributions of U-238 and Pu-240 were reduced somewhat arbitrarily by factors of 21.7 and 7, respectively, over the dilute values of Westcott. The epithermal contribution to the above exposure data is that appropriate to a D_2O moderated reactor such as the NRX. Calculations can readily be extended to other values of parameters and have already been made for epithermal contributions bracketing the one giving the results reported here.

A preliminary comparison of three enrichment schemes for the PRPR yields the following results for 5000 MWD/T exposure:

	Pu-Al Spike	Uniform Pu-UO_2	Uniform Enrichment No Recycle
Volume fraction enriched	30%	100%	100%
UO_2 inventory	5.12 tons	6.014 tons	6.014 tons
Pu-239 inventory	11 kg	19 kg*	7.6 kg
Cycle averaged eta	1.45	1.54	1.54
Reactor average p	0.90	0.84	0.84
U-235 enrichment of feed	0.72%	0.72%	1.35%

*Required for criticality; only 14 kg supplied by equilibrium cycle operation.

These results indicate more favorable characteristics for Pu-Al spike. However, the uniform case with reduced UO_2 effective density, a case not shown, should be still more favorable.

Similar calculations were performed for the 400-MW sample reactor case being reported on by E. A. Eschbach and M. Lewis. This study included an economically attractive method in which plutonium is recycledin a reduced density natural uranium oxide mixture to an "enriched zone" of the reactor, the rest of the reactor being fed with full density uranium oxide.

Experimental Reactor Design

Calandria and Reflector. Considerable simplification in the design and fabrication of the calandria and reflector tanks was achieved by a reduction in overall tank diameter and height and elimination of double walls between the light water reflector and heavy water moderator. New drawings have been prepared and will be issued for comment.

Reactor Piping. Outlet piping has been revised to conform with changes in the reactor and building. The jumper piping pattern was altered to allow space for the revised shim controls, which must be accessible from the top of the reactor. Ring header diameter was decreased from 16 feet (centerline to centerline) to 13 feet.

An alternate inlet arrangement using angle valves is being prepared since these valves are less expensive and appear to have an allowable pressure drop.

Process Tube Assembly. The outlet assembly is being revised to incorporate some simplifications in the nozzle and biological shield. Leak detector sample lines are now connected to the gas seal bushings on the top face.

The rough draft of the process tube assembly design criteria has been revised.

Fuel Element Assembly. Inspection of the dummy 19-rod cluster fuel element (Pb-Zn alloy canned in stainless steel), prepared by Ceramic Fuels Development Operation according to the Canadian NPD design, indicates that the bracket design is unsatisfactory for PRPR use. These brackets can damage

process tubes and nozzles during charge-discharge and do not appear to be of sufficiently strong construction.

Process Piping and Equipment. The steam generator heat exchanger was redesigned in order to utilize a "U" type construction recommended by B and W and Combustion Engineering. The location of the heat exchanger was changed by rotating the unit 90° in a horizontal plane so that the axis is parallel to the radius of the building.

The main primary pumps were reoriented to minimize D_2O holdup and be consistent with the revised location of the inlet and outlet ring headers.

Charge-Discharge. The fueling vehicle discharge mechanism has been revised to handle process tubes with nozzles attached in addition to its prime function. This requirement necessitated enlargement of the inside tube of the discharge cask in order to clear the outlet connection elbow which protrudes from one side of the nozzle.

The shielding disc in the reactor hall floor has been revised to facilitate the new handling requirements. In the previous arrangement one of four holes in a single rotating member was indexed over a process tube. The larger holes required for removal of nozzles compromised the effectiveness of shielding with this arrangement. The present arrangement has eccentric "wheel within a wheel" with a single hole in the inner disc. With this scheme the shield may be more positively aligned over any tube, which permits use of a much smaller hole, improving effectiveness of shielding.

Design changes have been completed for the transfer conveyor system used for transporting fuel elements through the containment barrier to the storage basin. This change eliminates the 50-foot deep sump in the storage basin.

Control and Safety Systems. Scope drawings (SK-1-6355) were issued on the totally enclosed shim control system. In this system two independently adjustable "half rods" are provided in each of 18 positions in the reactor. Each "half rod" is individually driven by a geared miniature motor, and indication of its position is given by a Selsyn-type transmitter. The complete mechanisms are entirely contained within the calandria and the top and bottom biological shields, and may be removed from the reactor with the charge-discharge equipment.

Reactor Instrumentation. During the month of April criteria for the reactor thermocouple monitor system and the reactor safety circuits were issued for comment. The reactor thermocouple system will be affected by design changes in reactor shielding which are under consideration. Required revisions to the criteria and the scope drawings will be made when the design changes are established. The water activity monitor system is being reviewed.

Shielding. Two developments permitted rescoping of the PRP shielding: (1) elimination of the requirement for minimizing activation of interior components of the PRP thermal and biological shields, and (2) the availability at no cost of heavy aggregates left over from 100-K. An

investigation of the quantities of excess steel punchings and limonite

Hazards Analyses

Safeguards Analysis and Report. Discussions of the safeguards analysis of the PRPR and the preliminary hazards report with personnel of the Hazards Evaluation Staff and the Division of Reactor Development were held in Washington, D.C., on April 16. The important points which will be thoroughly covered in the preliminary safeguards report are: (1) a description of the site including meteorology, geology, hydrology, defense installations, and population of surrounding areas; (2) a description of the reactor including lattice physics and safety systems; (3) a description of the containment structure; and (4) analysis of the overall hazard to the public.

D. CUSTOMER WORK

Radiometallurgy Service

Examination of VSR #55 from 105-KW. It was determined that the cause of cyclical dimpling at regular intervals along the length of KW Vertical Safety Rod No. 55 was due to the operation of the Ball 3X System with the vertical safety rod in the down position.

KE Reactor Slug Failures. The examination of two failures from the KE Reactor (Failure No. 739 from tube 4573 and Failure No. 740 from tube 4771) has been completed. Both were split type failures with large hot spot areas on the jackets. The hot spot areas of both slugs were found to have undergone intergranular attack; however, it did not appear that this attack had completely penetrated the jacket of either slug. The core of the uranium of each slug was found to have been heated above the beta phase transformation temperature over nearly the entire slug length. In each case the transformed zone was found to be offset toward the hot spot side of the slug. The results of this examination indicate that failure of these slugs was caused by excessive stresses created by the beta phase transformations undergone by the uranium cores. Overheating of the slugs was apparently caused by misalignment of the slugs in the process tubes.

Examination of Ruptured Slug from 3659-C. After a hot start-up at 105-C reactor nine ruptures occurred in seven tubes in a localized area. One of the ruptures was selected by IPD and submitted to Radiometallurgy for examination to determine the cause of failure, and especially to note indications of operation in the beta phase. The rupture was a standard eight-inch solid slug with an exposure of 520 MWD/T and had been in the reactor 136 days. Preliminary examination showed the uranium to be split the full length of the slug. There were no hot spots observed on the slug jacket.

Metallography Service

Metallographic examinations have been undertaken to evaluate the quality of the spot welds in the modified mercury switches which are an integral part of the 100 Area Panellit pressure monitoring systems. The examination disclosed that the welds were sound as evidenced by the good bonds between the various metal components. No significant attack by the mercury either by amalgamation or by intergranular penetration was found on the welds or the metals involved. Examination of one of the parts (a platinum wire loop which serves as one of

the contacts and is wet with mercury constantly) revealed that the platinum was attacked slightly by the mercury. The amount of attack was measured to be one to two mils, or about five to ten per cent of the cross-section of the wire. Subjecting the switch bottles to a temperature of about 150 F for periods up to two months has had little or no effect on the rate or degree of attack by the mercury. Current plans call for the periodic examination of switches which have been subjected to conditions simulating those experienced in use.

Metallographic work carried out for the Fuels Fabrication Development Operation has revealed that the beta-to-alpha transformation in uranium may be a compromise between non-diffusion and diffusion processes. The predominance of either process is influenced by the cooling rate through the transformation point. Therefore, the cooling rate determines the final grain appearance. Specimens quenched from 730 C into an isothermal bath at 635 C for various periods of time before final water quenching have shown a noticeably larger grain size after ten seconds in the bath. This coincides with a change in hardness values at this same point. A reduced degree of twinning (of the crystal structure) at and beyond 1000 seconds is accompanied by another definite change in hardness values. Beyond the 1000-second exposure to the isothermal bath, the grains have a progressively more regular appearance with fewer subgrains and more definite grain boundaries. This change is accompanied by a gradual decrease in hardness. Using a 400 C isothermal bath, there was very little change observed with increasing time in the bath. The appearance of these samples is very much the same as the appearance of direct water quenched samples. Further work is expected to provide additional information relating the alpha-uranium structure to the cooling rate through the beta-to-gamma transformation point.

Samples Processed During the Month

Total samples processed: 207

Photographs:

Micrographs	206
Macrographs	65
Total	271

L. P. Bupp

Acting Manager, Reactor and Fuels
Research and Development Operation

LP Bupp:kb

[redacted]

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
EA Evans	4/3-4	WAPD, Pittsburgh	Attend Oxide Panel Meeting	Jack Belle	Yes
	4/4-5	ANL, Lemont, Ill.	Discuss ceramic fuel fabrication equipment	J Schumar	"
	4/4-5	Kux & Clearing Press Co., Chicago	Discuss fuel assembly & costs	--	No
SH Bush	4/11-12	KAPL, Schenectady	Discuss HAPO Assistance program	DW Lillie	Yes
JC Tobin	4/15	U. of Michigan, Ann Arbor, Mich.	" metallurgy	--	No
	4/16	Case Institute, Cleveland, O.	" "	--	No
	4/17	WAPD, Pittsburgh	" metallurgical research problems	RH Fillnow	Yes
	4/18-19	BMI, Columbus, O.	Discuss research problems	FR Shoeber	Yes
EA Smith	4/15-17	Chicago, Ill.	Symposium on Non-destructive Testing	--	No
	4/18	Alcoa, Edgewater, N.J.	Consultation about process for making components	Norman Olson	No
	4/19	GE, Schenectady	Information on Non-destructive Testing	--	No
DC Kaulitz	4/2-3	Bureau of Explosives, New York City	Get approval from Bureau to construct cask	Mr. Campbell	No
	4/4	Hull Corporation, Abbington, Va.	Discuss fuel element fabrication	Mr. Hull	No
WP Wallace	4/30	Fernald, Cincinnati	Attend Metal Working Committee Meeting	--	Yes
DW Brite	4/10-11	Portland, Oregon	Attend AIME Convention	--	No
JA Ayres	4/10	Spokane, Wn.	Deliver talks on corrosion at Corrosion Short Course sponsored by Washington State College and National Association of Corrosion Engineers	--	No

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
AB Burgess	4/18-19	BMI, Columbus, O.	Consultation on creep testing program	FR Shoeber	Yes
DE Johnson	4/22	Westinghouse, Idaho Falls, Ida.	Technical consultations on materials	LE Hope	No
	4/23	GE, Idaho Falls	" " "	G Allred	"
	4/24	Sundstrand, Denver	" " "	PG Brockish	"
JM Atwood	4/12	MSA Research, Callery, Pa.	Discuss organic coolant technology	JW Mausteller	No
	4/15	AEC, Washington, DC	" " " "	UM Staebler	Yes
	4/16	" "	" " " "	RP Schmitz	"
	4/17	WAPD, Pittsburgh	Attend Aluminum Alloy Task Group Meeting	RG Scott B Lustman	" "
	4/18	Babcock & Wilcox Research Center, Alliance, Ohio	Discuss PRPR corrosion problems	W Markert	No
JO Ludlow	4/1-5	Babcock & Wilcox, Philadelphia	Technical consultation on valves and ion exchange resins	--	No
M Lewis	4/6-17	ACS Meeting, Miami	Recruiting	John Wolfe	No
		U of Michigan	Address science department	MJ Sinnott	No
		Ohio State	" " "	A Sessler	No
NG Wittenbrock	4/16-17	AEC, Washington, DC	Discuss safeguards analysis & reports for PRPR	Cliff Beck UM Staebler	Yes "
RM Fryar	4/21	Western Gear Co., Seattle	Consultation on design for PRPR	RT Hawley	No
ID Thomas	4/1-4	Dow Chemical Co., Rocky Flats, Colo.	Discuss project fabrication work	R Gauthier	Yes
JM Jefferes ED McClanahan	4/29-30	UCRL, Livermore, Calif.	Discuss metallurgical problems in connection with Project Whitney	JC Duncan WJ Ramsey	Yes

VISIT TO HANFORD WORKS

Name	Dates of Visit	Company Represented and Address	Reason for visit	HW Personnel Contacted	Access to Restricted Data	Areas and Buildings Visited
J Whealdon	4/2	Garrett Corp., Seattle, Wn.	Engineering conference	R Harrington	No	300, XXX
HW Cooper	4/5	Superior Tube Co., Norristown, Pa.	Discuss contract DDR-5, also potential uses for zirconium alloys at HAPO	JW Riches	Yes	300, 303 100-K Areas
AT Scattergood	4/8-10	Fenn Mfg. Co., Hartford, Conn.	Discuss fabricating equipment	DC Kaulitz	Yes	300, XXX
P Berner		Star Machinery Co., Seattle, Wn.	"	"	"	300, XXX
RJ Creagan RK McGeary	4/11	WAPD, Pittsburgh	Discuss plutonium-containing fuel elements and heat transfer technology	EA Evans JJ Cadwell LP Bupp LH McEwen	"	300, XXX
JC Duncan	4/16-18	UCRL, Livermore, Calif.	Discuss Hanford Assistance to UCRL	ID Thomas	"	200-W, 231
E Epremian DK Stevens	4/29-30	AEC, Washington, DC	Visit metallurgists and tour the site	JJ Cadwell SH Bush	"	300, 306 100-K

PHYSICS AND INSTRUMENT RESEARCH AND DEVELOPMENT OPERATION

MONTHLY REPORT

APRIL 1957

FISSIONABLE MATERIALS - 2000 PROGRAM

METALLURGY

Nuclear Safety - Buckling Measurements on Enriched Uranium, Water Lattices

Experiments were conducted with enriched uranium in water lattices. The enrichment was 1.466% and the fuel elements were of the I and E type (1.394" O.D., 0.464" I.D.). Measurements were taken at three different lattice spacings, these were: 2.0, 2.2, and 2.6 inches. The experiments are intended to show the feasibility of making buckling measurements with similar fuel elements of 1.6% enrichment in which case the number of rods in the lattice assembly must be kept small ($\sim$ 30 - 40) for nuclear safety reasons.

Part of the error in the measured bucklings depends on the uncertainty in $R - \lambda$; as the effective cylinder radius (R) is reduced it becomes necessary to know the reflector savings (λ) more accurately. The reflector savings is expected to be essentially the same for the 1.466% and 1.6% enriched uranium; data is therefore being obtained with the 1.466% uranium which will furnish information on the appropriate reflector savings to be used for the 1.6% case.

In previous buckling calculations a value for the water reflector savings was estimated from Brookhaven measurements where fuel elements of a different diameter and enrichment were used; however, the Brookhaven data indicated the reflector savings to be principally a function of the H_2O/U - volume ratio rather than the rod size.

If it is assumed that the reflector savings does not vary with the effective size of the cylinder then it is possible to evaluate this reflector savings by measuring the relaxation length in the same lattice, but with different sized cylinders, i. e., with different numbers of rods in the lattice assembly.

Measurements which have been completed are summarized below in Table I (in which case the bucklings were calculated with reflector savings estimated from Brookhaven data). In Table II preliminary values are given of the buckling and reflector savings which best fit the relaxation lengths determined from the different pile loadings. In evaluating λ', as given in Table II, the 49-rod loading for the 2.0" spacing was not used since in this case there is an extraneous variation of the equivalent radius dependent upon the placement of the tubes in the periphery of the loading. The calculation for the 2.6" lattice was not completed, and a measurement with 31 rods is pending.

Table I

Separation between Rods (inches)	H_2O/U*** (by volume)	Reflector Savings* (in cm.)	Number of Rods in Lattice	Buckling (10^{-6} cm^{-2})
2.0	1.39	7.52	31	5877
2.0	1.39	7.52	43	5936
2.0	1.39	7.52	49	6002
2.0	1.39	7.52	55	5971
2.2	1.92	7.14	31	6229
2.2	1.92	7.14	43	6307**
2.2	1.92	7.14	55	6438**
2.6	3.15	6.67	43	4296
2.6	3.15	6.67	55	4495

* Estimated from Brookhaven data.
** Reported in previous monthly report.
***With water in core.

Table II

Separation between Rods (inches)	Buckling (10^{-6} cm^{-2})	Reflector Savings λ' (in cm.)	$\lambda' - \lambda^*$
2.0	6086	7.32	-0.20
2.2	6720	6.57	-0.57

In the last column of Table II the difference is given from the reflector savings estimated with Brookhaven data.

It should be pointed out that with only three sets of data for each lattice spacing, the fitted reflector savings and buckling are very sensitive to each of the relaxation lengths; an error in any one measurement can have an appreciable effect on the results; these preliminary results are subject to further analysis.

Distinguishing Between Natural and Enriched Uranium Fuel Elements in a Sigma Pile

Some preliminary measurements have shown that it is possible to distinguish between two fuel elements, which differ only in enrichment, by comparative counting in a sigma pile. With an optimum separation between the neutron source, the fuel element, and the BF_3 counter, a difference in counting rate of about 3% was obtained when a single 8", natural uranium, fuel element was compared to that of a similar 1.44% enriched-uranium slug. With this enrichment difference, a total accumulated count of about 50,000 would be sufficient to separate the slugs. By taking larger counts it might be possible to separate

fuel elements by this means when the enrichment difference is as small as ~0.4%, i. e., to distinguish between 0.71 and 1.1% enriched uranium.

Instrumentation

A Kodak Projection Comparator was modified for use in measuring braze line widths and various contour diameters of fuel elements being fabricated. The instrument consists of a system of mirrors and lenses and a 1000-watt lamp so arranged as to project an image of the end of a fuel element on a screen at a magnification of ten times. Measurements are then made on the image using a specially prepared transparent template for comparison to determine if the fuel element dimensions fall within the specified tolerances.

Fabrication and testing was completed on an underwater viewer designed to permit the inspection of fuel elements being weighed at the 105-C fuel examination facility. The resolving power at the field lens of the eyepiece was found to be 40 lines per millimeter in the horizontal and 20 lines per millimeter in the vertical. This permits resolving objects less than a millimeter in diameter at 44 inches from the viewer. The field of view and the magnification also proved more than adequate for the intended application.

REACTOR

STUDIES RELATED TO PRESENT PRODUCTION PILES

Buckling of Enriched Uranium Graphite Lattices

The buckling was determined for 1.44% enriched, I and E fuel elements in an 8-3/8" lattice with C-pile-type process tubing. The canned dimensions of these elements were 1.47" O.D., 0.37" I.D.; uncanned dimensions were 1.37" O.D., 0.048" I.D. The buckling values were 580 and 572 microbucks for the dry and wet lattices, respectively. The bucklings for natural uranium, I and E fuel elements in the same lattice were previously measured as 114, and 60.5 microbucks for the dry, and wet lattices. These measurements were taken in a small (~4' x 5' x 7') exponential pile.

Buckling of Natural Uranium, Graphite Lattices

A series of buckling measurements were started in the small (~4' x 4') exponential piles using natural uranium, I and E fuel elements with uncanned dimensions of 1.37" O.D., 0.48" I.D., and canned dimensions of 1.47" O.D., 0.37" I.D. The following results were obtained during April:

Lattice Spacing	Al/U	C/U	Cooling Annuli Condition	H_2O/U	Buckling (10^{-6} cm^{-2})
8-3/8"	0.598	98.0	Dry	-	127 ± 10
			Wet	0.340	74 ± 10
7-11/16"	0.598	82.2	Dry	-	125 ± 10

The ratios are expressed in terms of atoms per unit of cell. Since measurements have previously been taken with similar type, 1.44% enriched fuel elements,

these data will provide additional information on the shift of the crossover point buckling with enrichment; the crossover point is the lattice spacing for which the dry and wet bucklings are of equal value.

Thermal Test Reactor

The whole reactor temperature coefficient measurement was completed. It was found that the amount of water in the annulus and fuel tubes affected the temperature coefficient considerably. The coefficient at the optimum water levels of the annulus and fuel tubes is + 1.81 cents/°C.

To measure the temperature coefficient of the reactor when only the temperature of the fuel tubes are varied, a preliminary investigation has shown that it will be possible to vary the density of the moderator in the fuel tubes without varying the temperature by replacing the water in the fuel tubes by various mixtures of kerosene and paraffin oil. The change in density obtained would be the same as that obtained in water if its temperature was changed 150° C or more.

Bubbles have reappeared in the fuel tubes, possibly caused by heating during the temperature coefficient measurements. With a large concentration of bubbles in the fuel tubes, a pressure coefficient of + 0.025 cent/mb was measured.

Coolant Loss Problem

The first set of analog computer runs for this problem have been completed. The data was delivered to I.P.D. personnel in order to evaluate the validity of the simulation and to determine the direction of future runs.

The first set of runs evaluated the coolant loss problem for the following conditions:

1. Coolant reactivity - 300, 600, 900, and 1200 inhours.

2. Vertical rod strength - 2000 and 1500 inhours.

3. Vertical rod acceleration - normal and fast.

4. Pannellit trip times - 0.2, 0.4 and 0.6 sec.

A report describing the computer set up and the preliminary runs will be issued shortly. Since IPD will perform the analysis based on the computer runs no attempt will be made to include an analysis in this report.

STUDIES RELATED TO FUTURE PRODUCTION PILES

Crystal Spectrometer

The rectangular slit beam collimators which were recently installed for good energy resolution in the 1 - 10 ev energy region have been aligned and tested. The collimators were determined to give the expected beam intensities and angular collimation. This angular collimation was used to study more closely the structure of several crystals which have been used for monochromators. The beryllium crystal has been found to suffer severe lineage with an extreme angular displace-

ment of about 20 minutes between crystallites. The crystallites apparently are each very perfect crystals with mosaic widths of the order of seconds of arc. With this angular collimation, the reflection from only one crystallite can be utilized. The net result is a loss in diffracted intensity of about two orders of magnitude below that which could be obtained from a crystal with a more optimum mosaic structure. A more suitable crystal must be found before the fission measurements with good resolution can be started.

Pu-240 Total Cross Section

The Be (1235) planes have been used with the new slit collimators to give a resolution of about 0.8 percent at 1 ev (0.28 μsec/m). Total cross-section measurements have been made on a sample of plutonium to study the 1 ev resonance in Pu-240. This sample contains only a small fraction of Pu-240 (about 0.4%) and the exact value is not known so that a complete determination of the parameters of this resonance cannot be done at this time. It is possible to do an analysis of the level width without a knowledge of the sample thickness (Pu-240 content). A preliminary analysis has been done with only about one-half of the data which will be obtained on this resonance. The analysis has led to a probable value for the level width, Γ , which is somewhat smaller than the presently accepted value and is in substantial agreement with a value fabricated to fit cross-section values obtained from reactor analysis at Chalk River.

The data have been obtained with a resolution width of 8 mv. The probable resolution correction is small and is such as to decrease the inferred level width but no resolution corrections have been applied in the preliminary analysis. The observed level width was ($52.8 \pm \sim 3$) mv at an energy E_o of 1.057 ev. Using the calculated doppler width of 21.1 mv, we calculate a true width of ($28.6 \pm \sim 3$) mv for this level. The doppler correction is a very sensitive one and a more refined analysis will be made of the final resolution corrected data. The presently accepted value of the width is 39 mv (BNL-325) and the value fabricated by Westcott at Chalk River is 28 mv.

Millimicrosecond Time Analyzer

An order was placed with RCL for the 256 channel analyzer to be used for data storage with the millimicrosecond time analyzer. A formal report has been written on the time analyzer. Work is in progress on a discriminator circuit for use with a high speed scaler.

Evaluation of Lattice Parameters for IPR Program

Final values of the lattice parameters for the 1.68", and 1.93", solid, natural uranium, fuel elements, as evaluated jointly by Nuclear Physics Research and IPD personnel, are given as follows:

1.68", Solid, Fuel Element in 7-1/2" Lattice

Coolant Annulus	δ *	ϵ *	F_{th}*	f	P	Initial Conversion Ratio
Dry	0.081	1.043	1.380	0.939	0.763	1.079
Water	0.081	1.043	1.380	0.900	0.806	0.980
MIPB	0.081	1.043	1.380	0.912	0.794	1.006

δ is the ratio of the fissions which occur in U-238 to those of U-235, and F_{th} is the thermal disadvantage factor as normally defined. In the above case the volume of the coolant annulus was 4.6 cc/cm of process tube.

1.93", Solid, Fuel Element in 8-3/8" Lattice

Coolant Annulus	δ *	ϵ*	F_{th}*	f	P	Initial Conversion Ratio
Dry	0.0997	1.053	1.458	0.938	0.755	1.103
Water	0.0997	1.053	1.458	0.899	0.777	1.061
MIPB	0.0997	1.053	1.458	0.908	0.777	1.056

In this case the coolant annulus volume was 5.5 cc/cm of process tube. An error analysis has thus far not been completed for the above cases.

The following tentative, preliminary values are given for the 1.93" O.D., 0.75" I.D., cored, fuel element in an 8-3/8" lattice.

Test Condition	δ	ϵ	F_{th}	f	P	Initial Conversion Ratio
(a)	0.0704	1.0374	1.325	0.934	-	-
(b)	0.0819	1.0435	1.317	0.893	-	-
(c)	0.0745	1.0395	1.265	0.885	0.791	1.025

(a) Coolant annulus dry, core dry.

(b) Coolant annulus wet, core dry. (Volume of coolant is 5.5 cc/cm of process tube).

(c) Internally and externally water cooled. (Volume of coolant is 8.35 cc/cm of process tube.)

* Based on average fluxes from all three experiments in which δ, ϵ, and F_{th} were assumed to be independent of the lattice components external to the slug, since measured differences were within the experimental accuracy of the measurements.

P_3 Programs on the Digital Computers

The multi-region P_3 program for the 702 computer has been completed. The difference which existed in the results obtained from the 650 program and the 702 program has been rectified. The results of a sample case calculated on the two programs are given below. This case is for a 1.36", natural uranium, fuel element in an 8-3/8" lattice. Water is present in the cooling annulus. The ratios of the average thermal neutron fluxes in regions 2, 3, 4, and 5 to the average flux value in region 1 are listed for purposes of comparison. The various regions are designated as:

1) uranium
2) can wall
3) water
4) process tube
5) graphite

	702 Computer	650 Computer
ϕ_2/ϕ_1	1.28103	1.28054
ϕ_3/ϕ_1	1.45738	1.45672
ϕ_4/ϕ_1	1.61823	1.61741
ϕ_5/ϕ_1	2.13001	2.12812

Correlation of Theory with Experimental Buckling Measurements

The "experimental buckling reduction" IBM-702 code is debugged. Practice runs are now being made with actual data. This code reduces exponential pile counting rates to bucklings. Its completion obviates the current necessity for extensive hand reduction data.

Spatial Dependence of Neutron Temperature

The following problem has, in principle, been solved: A point neutron source emits a Maxwellian spectrum characterized by the temperature T_0 into an infinite medium of heavy gas molecules held at temperature T_1. What is the spatial dependence of the neutron temperature?

The solution is accomplished by expanding both the kernel and solution of the defining integral equation into series in the ratio of neutron mass to scatterer mass.

SEPARATIONS

Nuclear Safety Problems

The nuclear safety aspects of the following plant operations and/or modifications have been examined, and recommendations tendered accordingly:

1) Installation of a new fabrication line in 234-5 Building.

2) Hanford processing of exposed fuel elements derived from the civilian nuclear power industry.

3) Installation of new slug dissolvers in Purex and Redox capable of handling 0.94% enriched material.

4) Installation of continuous ion-exchange equipment in purex.

5) Installation of additional process vessels in Recuplex.

Plutonium Mass Spectrometer

An appropriation request has been written for funds to fabricate a thermionic emission, 12-inch mass spectrometer for isotopic analyses of heavy elements in support of the research programs of Nuclear Physics Research Operation.

Neutron Age Measurements

A production test has been issued as HW-48434 to cover the irradiations of the Na-Be photoneutron sources for the age measurements.

Homogeneous Criticality Experiment

Further analyses and preliminary measurements have been made of k_∞ for homogeneous, slightly enriched, UO_3 - H_2O mixtures. The results now indicate that k_∞ = unity for an enrichment of 1.15% and an atomic hydrogen-to-uranium ratio of about 10. From these results, together with previous data, it can be estimated that such mixtures are most reactive for H/U in the range of 7 to 8 and that about 1.05% is the maximum enrichment for which k_∞ is always less than, or equal to, unity.

Pu Critical Mass Facility

The scoping for a "minimum" critical mass laboratory has been started. A possible location for the critical mass laboratory is in the 200-E Area adjacent to the Hot-Semi-Works where containment would be provided by a steel structure about thirty feet in diameter with spheroidal ends; experiments would be conducted from a remote control center utilizing distance for shielding; a hazards study is being made for the possible location of this facility in the 200-E Area.

INSTRUMENTATION AND CONTROL

Systems Research

The reactor simulation circuits previously developed have been used in computing the results of loss of coolant from existing reactors. This work was reported above. A problem on the isotopic composition of PRPR fuel was also begun. This work is reported in more detail under the 4000 program.

The additional problem boards and patch cards on back order are expected to be delivered by mid-May.

Service personnel from Goodyear arrived April 23 to service the equipment and to replace the side control panel with a new unit.

Components Research and Development

Development continued on the experimental detecting system for determining the low energy limitations of scintillation X-ray and gamma detection. The basic concepts were experimentally proven to be applicable, therefore a more advanced system is being fabricated to experiment with the various possible techniques of application. The system will utilize cross correlation to reduce the background and noise effects.

A survey was completed on information storage devices for investigating possible application of the techniques to Hanford problems. An example of one such technique being investigated is the recording on magnetic tape of pulses from radiation detectors for subsequent analysis on multichannel analyzers.

Fabrication continued on an experimental pulse matrix system for a Radioisotope Analyzer. The three channels are essentially completed.

WEAPONS - 3000 PROGRAM

Magnetic Balance

Testing of the electronic system of the magnetic suspension balance has continued. The desired precision of measurement has not been attained as yet.

REACTOR DEVELOPMENT - 4000 PROGRAM

STUDIES RELATED TO THE PLUTONIUM RECYCLE PROGRAM

PCTR Lattice Measurements

The data for the 7-inch D_2O lattice with dry process tubes have been completed in the PCTR experiments. Data have been taken with three different fuel element assemblies: a 7-rod cluster of UO_2 elements, a 19-rod cluster of UO_2 elements, and a cluster of 16 UO_2 and 3 Pu elements. Detailed calculations of k_∞ and thermal utilizations for these fuel configurations are under way. A preliminary value of $k_\infty = 0.992 \pm \sim 0.005$ has been determined for the 7-rod cluster. The k_∞ values for the other configurations appear to be larger than unity but no preliminary values have been obtained. Measurements have been started on the wet 19 UO_2 rod cluster and the wet 16 UO_2 - 3 Pu rod cluster.

PCTR Operations

Operation of the Physical Constants Testing Reactor continued routinely during the month with two shifts beginning on April 16 and continuing through month end. Two unscheduled shutdowns resulted from improper by-pass switch operation, and five were caused by instrument malfunction. Four of these occurred on one 4-12 shift when instrument maintenance was not available.

All experiments performed during the month were in support of the Plutonium Recycle Program.

Material Balance Problem

The first analog computer run in the initial phase of the problem to determine the isotopic content of the fuel as a function of time in the reactor has been completed. In this run the following reactor variables were considered as constants:

Flux	5×10^{13}
Eta	1.30
Epsilon	1.03

A fuel rod of natural uranium oxide was given a year of exposure. The rod was then considered to have been chemically separated and all of the Plutonium was mixed with natural UO_2 for the next year of exposure. This was continued until the various isotopes of Plutonium reached equilibrium. Plutonium-239 reached equilibrium during the fourth year of exposure; Pu^{240} during the fifth year; and Pu^{242} during the seventh year.

The second phase of the problem will include eta as a variable; the other reactor dependent variables will be included as variables in the subsequent phases.

BIOLOGY AND MEDICINE - 6000 PROGRAM

BIOPHYSICS RESEARCH

Atmospheric Physics

Major effort within the Atmospheric Physics Operation was devoted to the conduct of field experiments and preparations for these experiments. Two experiments designed to measure the vertical distribution of concentration in stable atmospheres were attempted on April 9 and April 19. The first of these failed but the second was very successful, providing highly reliable estimates of the vertical distribution of concentration at 500, 1000, and 2500 feet from an elevated point source. These measurements provided striking confirmation of the concepts advanced previously in these studies and they also provided data of fundamental importance in the proper assessment of the diffusive capacity of non-neutral atmospheres. In particular these and earlier experiments demonstrate that the classical diffusion models tend to underestimate the average concentration quite seriouslyin the case of stable atmospheres.

Preparation of the polar sampling grid out to 2500 feet from the Meteorology Tower was completed and all ground based samplers and battery operated pumps were inspected and prepared for experimental work on diffusion in unstable atmospheres.

Consultation services were provided to C.E.O. on an air pollution problem in the 100-K Area. Since some experimental work in this Area is required for the proper resolution of this problem a series of experiments was agreed to and all necessary preparations completed. Conduct of the experiments was delayed pending suitable meteorological conditions. Consultation services were also provided the Industrial Hygiene Operation on a pollution problem in the 200-W Area garage.

Operation of the wind station network continued satisfactorily and data from this network were reduced on a routine basis.

DOSIMETRY

The coincidence scintillation counter for plutonium detection has been modified. The lucite light pipe has been replaced by a light pipe with thin lucite walls and filled with mineral oil. If the background count due to light produced within the light pipe were due to weak scintillation properties of the lucite, this light pipe should eliminate most of them. If these background counts were due to Cerenkov radiation, little change would be expected since the index of refraction of lucite and mineral oil are nearly the same.

Samples of material to be used in the Body Monitor Facility are being tested for natural radioactivity. A NaI(Tl) scintillation counter in a lead and iron shield is used for the tests.

The 330 cubic-inch plastic scintillator has been machined to fit the surface of a 14-inch photomultiplier. This provides a better and more stable optical coupling. The scintillator and photomultiplier have been assembled and partially shielded for possible monitoring applications.

The background suppressors were installed in the Van de Graaff accelerator 25° plumbing. Installation of some of the associated wiring and water cooling lines remains to be completed. Except for the time spent in this installation and subsequent leak testing, the accelerator has been in routine operation during the month.

Measurements with the double moderator neutron detector disclose a striking difference in the sensitivity of the fluxmeter relative to the long counter when measured with neutrons from the Van de Graaff accelerator and when measured with neutrons from radioactive sources. When neutrons from radioactive sources are used, the sensitivity relative to the long counter is constant with neutron energy. However, when neutrons from the accelerator are used, the sensitivity relative to the long counter becomes a function of neutron energy. Further investigation of this effect is planned.

Preliminary studies are being made on the ionization chamber to be used to measure w for protons. The chamber was tested using 5 Mev alpha particles and a value of w = 39 ev/ip was obtained. Since this first measurement is quite rough, agreement with other published values for w is adequate. Further refinements of both the pulse counting and current measuring methods are being carried out.

In the measurement of w for tritium Beta rays, it is necessary to know the isotopic fractionation ratio for tritiated water on vaporization. The system for measuring this ratio has been received from the glassblower, and the measurements are being started.

Previous measurements with calibrated CP's and high-energy ionization chambers have indicated a possible discrepancy in the comparison of the 500 mg and 25 mg radium sources. This month a careful comparison of the two radium sources was made using a high-energy Victoreen Chamber. It was found that the ratio

of the radiation from the two sources equals the ratio of the radium contents within 1%. This small difference is probably due to the self-absorption of the larger radium source.

INSTRUMENTATION

A transistorized sine-cosine amplifier for the Wind Direction portion of the Radiotelemetering Data Stations was developed and tested for performance in various temperature and humidity environments. The tests were satisfactory.

A transistorized 60-cycle amplifier and phase discriminator was developed. This amplifier will be part of an emergency fail-safe protection system for Hanford piles.

Work was continued on airborne particle detection instrumentation and on photographic reproduction and recording of radioactive source strength and position when viewed by a moving scintillation scanning instrument.

Calibration and data collecting tests were continued on the scintillation fast neutron dose-rate meter using the positive ion accelerator. Attempts are being made to make the instrument follow the multiple collision dose-energy curve for fast neutrons. Detection threshold of the instrument with a 10 mg/cm^2 polyethylene wall and zinc sulfide seems to be about 200-250 Kev for fast neutrons using the T(n,p) reaction. Further work is contemplated to lower the threshold energy and raise the sensitivity.

Work is being continued on the scintillation, all-transistorized alpha Hand and Shoe Counter.

Further design work is being done on the dual-filter Alpha Air Monitor before the instrument is sent out for field testing. When modified and completely tested, the alarm sensitivity should be about 200 MPC of Pu alpha contaminant in three minutes.

Evaluation tests were completed on three GM instruments of our design. The three tested were initial samples of 97 ordered fabricated to our specifications. Evaluation tests were started on three, of an order of thirty, scintillation alpha poppies also being fabricated from our design specifications. Field testing of the single filter alpha, high level, detection and alarm instrument was continued.

CUSTOMER WORK

Weather Forecasting

Type of Forecast	Number Made	% Reliability
8-Hour Production	90	86.4
24-Hour General	60	83.3
Special	103	79.6

Summary of the Weather

The temperatures for April averaged 55.2 which was 1.4° above normal. The departure was due to a month-end heat wave in which the temperature reached a high of 89.

High winds occurred on the 14th and 30th. Blowing dust occurred on both dates and on the latter there was a thunder storm and hail.

Columbia River Forecasts

The preliminary forecast of crest heights on the Columbia River during 1957 was prepared and distributed. The presently forecast peak stage is approximately one foot below the peak observed in 1956. No serious flooding is anticipated.

Optical Shop

The routine optical shop work included the fabrication of ten glass bearings, an elbow telescope, six viewing windows, parts for the weigher-viewer, two platinum filaments, ten pieces of quartz tubing, ten quartz plugs, one quartz spacer, and four glass filters. The repair work included two crane periscopes, a theodolite, a borescope head, and a refractometer. Ten mirrors were aluminized and a camera was modified to add a focus adjustment.

Paul F. Gast

Manager
Physics and Instrument Research
and Development
HANFORD LABORATORIES OPERATION

PF Gast:mcs

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented & Address	Reason for Visit	H. W. Personnel Contacted	Access to Restricted Data	Areas and Buildings Visited
Gail Shook	Apr. 23	Univ. of Washington Seattle, Wash.	Job Interview.	J DePangher	No	300: 329 3745-B
KJ Hoffman D Porter	Apr. 23-May 1	Goodyear Aircraft Corp., Akron, Ohio	Service Analog Computer.	AE Tucker	No	300: 326

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
WC Roesch IT Myers	Apr. 4-6 Apr. 11-13	Univ. of Washington Seattle, Wash.	Instruct AEC Fellowship students.	--	No
JE Faulkner	Apr. 10	Los Alamos Scientific Laboratory Los Alamos, N. Mex.	Discuss nuclear physics experiments.	CW Zabel	Yes
PF Gast	Apr. 10-12	Oak Ridge School of Reactor Technology Oak Ridge, Tenn.	Lecture at School	FP Napp	Yes
GW Anthony ED Clayton JE Faulkner N Ketzlach	Apr. 11-12	Los Alamos Scientific Laboratory Los Alamos, N. Mex.	Attend Nuclear Safety Group Meeting.	HC Paxton	Yes
JJ Fuquay	Apr. 15-16	Univ. of Washington Seattle, Wash.	Conference with Staff Members.	PE Church FI Badgley RG Joppa	No
ED Clayton	Apr. 23	Reed College Portland, Oreg.	Present a paper.	Prof. Scott	No

VISITS TO OTHER INSTALLATIONS (CONT'D)

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
WC Roesch	Apr. 18-29	Univ. of Washington Seattle, Wash.	Instruct AEC Fellowship students.	--	No
		Project Tutor Washington, D. C.	Attend AEC meeting.	AD Starbird	Yes
		Nat'l Bur. of Stds. Washington, D. C.	Discussion for NCRPM.	HO Wyckoff	No
IT Myers	Apr. 25-26	Univ. of Washington Seattle, Wash.	Instruct AEC Fellowship students.	--	No
HW Lefevre	Apr. 25-27	Am. Physical Society Washington, D. C.	Present a paper.	--	No
		Oak Ridge Nat'l Lab. Oak Ridge, Tenn.	Discuss instrumentation.	PR Bell	No

Chemical Research & Development Operation

ORGANIZATION AND PERSONNEL

The planned interchange of personnel between Research and Engineering (CPD) and Chemical Research and Development (HLO) was extended to include eleven additional pairs through the balance of 1957.

Daisy C. Smith transferred into Analytical Laboratories Operation as a Laboratory Assistant from Exposure Records and Evaluation.

Carolyn L. Leinberger transferred into Analytical Laboratories Operation as a Counting Room Assistant from Exposure Records and Control.

Jack L. Welch was reactivated as an Engineering Assistant in Chemical Development Operation.

TECHNICAL ACTIVITIES

2000 PROGRAM - PRODUCTION OF FISSIONABLE MATERIAL

IRRADIATION PROCESSES

Reactor Effluent Studies

It is currently recommended that no reactor purges be made directly to the river when its temperature is above 15 C. It tentatively appears that the control of phosphorus-32 may be adequate if a limited number of purges are employed. The uptake by whitefish is not expected to be significantly increased by such action. Final recommendations will require the concurrence of Biology and Radioprotection Operations.

Direct measurement of isotopic content of reactor cooling water by gamma spectrometry was delayed by instrumentation problems. Arsenic-76 is now determined directly. Determination of Scandium-46 and Copper-64 has been slowed for lack of a large (3 inch) scintillation crystal

REACTOR EFFLUENT STUDIES

Process Assistance

Increases in amounts of radioisotopes discharged to the river have caused some concern that a production-limiting concentration may be approached in the not too distant future. Months of highest concentration are November through March. Low river flow during the winter period has contributed directly because of lowered dilution factors. As^{76}, Np^{239}, Rare Earths + Y, and the fission products in reactor effluent water have also increased during this period indicating that lowered dilution factors were not solely responsible. Of significance is the higher river turbidity reached during later 1956 and early 1957. This required increases in alum and filter aid to maintain cooling water quality. Increases in reactor power level during the interval also contributed to the observed increase. During this period also cooling water pH was decreased. Some data are available which indicate increases in effluent concentrations with decreasing pH. Although data are not

available for quantitative determination of increases in reactor effluent isotopes from changes in power, river flow, turbidity and pH. They may well be responsible. Further study of this problem is underway.

Laboratory experiments with 107 Basin water and sludge were completed to investigate the effect of variables such as pH and concentration of Turco 4306-B, a decontaminating agent, on the desorption of Cs^{137} and Sr^{89-90} from the sludge. Conclusions from this study will be formulated soon.

Automatic Analyzing Monitor

Widths of channels to be used for Mn^{56}, As^{76}, and Na^{24} appeared to be satisfactorily stable, however, some drifting of the channel width for the low energy Np^{239} peak caused some concern, since Compton contribution in this region from higher energy emitters could markedly influence the counting rate of the Np^{239} channel. Increasing the channel width will improve the situation, but variations in channel width may well be the limiting factor on accuracy of the Np^{239} measurement.

Improvements in electrical and electronic features were incorporated including provision for manually advancing stepping switches, more convenient calibration of the count rate meter, minimizing sparking of the toothed-wheel digitizer, and the incorporation of a new interval timer to establish the length of time allowed for the recorder to read data on the Streeter-Amet printer.

Necessary improvement in the continuous removal of interfering radioisotopes from the P^{32} stream of the monitor was not realized. An analysis of decay curves from previous runs showed that interference from As^{76}, W^{187}, and I^{133} had been as low as 10 per cent, indicating that under some conditions satisfactory performance in this respect should be attainable. High Si^{31} initially in the sample will contribute significantly to the P^{32} count made after 26 hours, and this was accounting for a portion of the earlier observed high values for P^{32}. The contribution from P^{32} can be reduced through a longer decay period, or a computed correction can be applied to the P^{32} count. A detailed chemical study of the mode of removal of arsenic will be necessary to prescribe exact conditions to insure efficient removal of As^{76} from the P^{32} stream. Investigations on the separation procedure will be continued by the Analytical Chemical Operation.

Analytical Chemical

Determination of plutonium in normal solid and I&E type fuel elements will be made by coulometric titration. Some problems have developed in maintaining plutonium valance state. The shielded equipment for gravimetric determination of Pu is scheduled to be in place by August.

Measurement of properties of organic coolant is undergoing improvements which should improve the flow of information. It was observed that about one-half of the tars formed in MiPB have melting points above 240 C vs. the assumed 220 C on the assumption that tesphenyl would have the highest melting point.

[redacted]

SEPARATIONS PROCESSES

PUREX

Phase II Flowsheet

The proposed Purex Phase II Flowsheet* for the HA Column was tested in a dual-purpose glass pulse column. The extraction section was 3-inch diameter by 9-foot high and contained a nozzle plate cartridge. The scrub section was 4-inch diameter by 9-foot high and contained a mixed plate cartridge (4 stainless steel - 2 plastic sieve plate configuration). Except for the omission of louver plates and the use of fluorothene rather than polythene as the plastic plate material, the cartridge were identical to those specified for the plant HA Column.

Extraction Section. Flooding frequencies for the extraction section with the organic phase continuous were not determined since the scrub section controlled column flooding. With the aqueous phase continuous, the extraction section controlled column flooding, and flooding frequencies of 105 ± 5 and 85 ± 5 cycles/minute at capacity factors of 1.8 and 3.6, respectively, were obtained. Increasing the column temperature to 45 ± 5 C increased the aqueous phase continuous flooding frequencies by about 15 per cent.

Uranium waste losses ranged from 0.01 to 0.04 per cent, which is approximately the same as obtained with Purex Plant Flowsheet IIA. The choice of continuous phase did not appear to influence column efficiency.

Scrub Section. Both flooding and efficiency runs were made under Phase II Flowsheet conditions. Scrub section efficiency runs were also made with:

(a) The secondary organic stream (HASO) off.
(b) The aqueous backcycle (3WB) off.
(c) Both HASO and 3WB off (equivalent to Purex Plant Flowsheet IIA conditions).

The results are summarized below:

1. With the organic phase continuous the scrub section controlled column flooding. Flooding frequencies of 105 ± 5 and 80 ± 5 cycles/minute at capacity factors of 2.4 and 3.5, respectively, were obtained. Increasing the temperature to 45 ± 5 C increased the flooding frequencies 15 per cent. Scrub section flooding frequencies were not determined for aqueous phase continuous operation since the extraction section controlled column flooding.

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* Nomenclature used in this report approximates that used in HW-47889, "Purex Phase II Proposed Flowsheet," W. H. Swift and E. R. Irish, 2/1/57. For example, 3WB refers to the backcycled waste stream introduced below the feed point in the HA Column. On the otherhand, the flowsheet calls for two organic streams to be introduced above the feed point. These are the IBSU stream (the organic effluent from the IBS Column containing 0.065 M UNH) and the HAO stream (fresh organic stream from the organic header). For the purposes of the study reported here, these two organic streams were considered as one stream, of HAO composition (no uranium), flow equivalent to the sum of the two streams, and called HASO in this report.

2. A good "zebra" effect (alternate phase inversion) was obtained under Phase II Flowsheet conditions. With the HASO stream off, the zebra effect was apparent, but the dispersion - especially, in the middle three-foot section - was considerably coarser. With the 3WB stream off, only a slight and erratic tendency toward a zebra effect was noted. With both streams off (equivalent to Purex Plant Flowsheet No. IIA conditions), the zebra effect was limited to the upper two-thirds of the scrub section.

3. The scrubbing efficiencies (measured by chloride transfer) obtained under Phase II Flowsheet conditions were approximately the same as obtained under Purex Plant Flowsheet No. IIA conditions. The efficiency was reduced by approximately 25 per cent by eliminating the backcycle (3WB). No appreciable effect was noted by eliminating only the HASO stream.

Permanganate Addition to Phase II Flowsheet

Since permanganate oxidation has been considered as one potential scheme to achieve neptunium recovery in the Purex Process, two runs were made in the equipment described above to observe the effect of potassium permanganate addition to an organic phase continuous HA Column. Purex Phase II Flowsheet was used with the following modifications:

(a) The HAS contained 0.02 M $KMnO_4$.
(b) 0.02 M Fe^{++} followed by 0.03 M $KMnO_4$ was added to the 3WB.

No adverse effect on phase dispersion was noted. The bulk of the manganese dioxide formed remained with the aqueous phase and was discharged from the bottom of the column. Some entrainment in the HAP was noted, however, causing a light brown color which disappeared after approximately 2-1/2 hours.

In the second run, the column was operated until steady state operation was reached. The addition of the HAS containing potassium permanganate was then stopped and regular HAS was started to determine if the manganese dioxide would scrub out of the organic and the length of contact time necessary. The organic phase in the cartridge section started clearing immediately, and the organic phase in the disengaging section was essentially free of manganese dioxide in approximately 15 minutes.

Organophosphorus Complexing Agents

The compounds ethyl dibutyl phosphonoacetic acid, dibutyl phosphonoacetic acid, butyl phosphonoacetic acid, and phosphonoacetic acid have been prepared and purified, and their properties as complexing agents for metal ions are currently under investigation. The physical properties of these compounds are summarized in Table I.

[redacted]

TABLE I

PHYSICAL PROPERTIES OF PHOSPHONOACETIC ACID AND ITS ESTERS

	Boiling Point or Melting Point (deg C/mm Hg)	Density (g/cc)	Refractive Index (nD^{25})	Solubility in H_2O (g/l)	Solubility in CCl_4 (g/l)	pK_a
1. Ethyl dibutyl phosphonoacetic acid $(BuO)_2P(O)CH_2C(O)(OEt)$ ("EDBPA")	121/0.85	1.0321	1.4340	-	-	-
2. Dibutyl phosphonoacetic acid $(BuO)_2P(O)CH_2COOH$ ("DBPA")	dec. > 50C	1.102	1.4444	17	-	3.4
3. Butyl phosphonoacetic acid $(BuO)(HO)P(O)CH_2COOH$ ("BPA")	dec. > 50 C	1.259	1.456	ca.250	0.2	2.1
4. Phosphonoacetic acid $(HO)_2P(O)CH_2COOH$ ("PA")	m.p. 143.4 C	--	--	984	>0.01	2.1

The completely esterified compound, 1, extracts uranyl nitrate in a manner similar to TBP. Compound 2, dibutyl phosphonoacetic acid forms salts which are organic soluble, the extraction reaction exhibiting the expected negative hydrogen ion dependence. Its behavior towards uranium and zirconium has been reported previously. Qualitative tests indicate that it forms organic soluble complexes with many ions, including cobalt, copper and uranium(IV). While cobalt and copper require a pH of about four for appreciable extraction (using 0.1 molar dibutyl phosphonoacetic acid in carbon tetrachloride), uranium(IV) extracts at a pH as low as 1. Table II shows typical extraction data for uranium(IV).

TABLE II

EXTRACTION OF 0.1 M UCl_4 WITH DIBUTYL PHOSPHONOACETIC ACID IN CCl_4

Conc. DBPA M	E_a^o U(IV) Aq. Phase pH = 1.0	E_a^o U(IV) Aq. Phase pH = 1.3
0.05	0.082	0.14
0.1	0.23	0.38
0.25	0.46	1.4
0.5	0.85	2.8

The extraction increases as the hydrogen ion concentration decreases as expected, and the extraction of uranium(IV) appears to be greater than that found for uranium(VI). However, the most interesting observation is that the uranium(IV)

polymer is the species that is most highly extracted. The spectra of the organic phases obtained at high pH values (and high E_g^o values) lack the peaks characteristic of uranium(IV) and resembles that of the aqueous polymer. Further, the saturated organic phase is found to contain approximately a two to one mole ratio of uranium(IV) to DBPA.

The terminal hydrolysis product of the series, phosphonoacetic acid might be expected to form aqueous soluble complexes (or precipitates) as does phosphoric acid, with the added factor of possible chelate formation. Complexing of zirconium by this compound was studied by following its effect on partition of zirconium into TTA. A concentration of 0.1 molar TTA in benzene was used to extract 10^{-3} molar zirconium previously prepared by TTA extraction. The addition of phosphonoacetic acid strongly complexed the zirconium as the data in Table III show.

TABLE III

COMPLEXING OF ZIRCONIUM(IV) BY PHOSPHONOACETIC ACID
Organic phase 0.1 M TTA in benzene
Aqueous phase 5 M $\bar{N}O_3^-$, H^+ as indicated

M H^+	E_g^o (Zr) No PA	E_g^o (Zr) 0.1 M PA in Aq. Phase
0.5	1650	0.04
1.0	450	0.04
2.5	50	0.05
5.0	8	0.01

No complexing experiments have been performed with the intermediate ester, butyl phosphonoacetic acid.

NEW PROCESSES

Chemical Dejacketing of Zircaloy Clad Fuels

The effect of major variables, temperature concentrations, time, and pH as they effect the dissolution of zircaloy in NH_4F solutions have been investigated. The applicability of the process to separations operations appears favorable. An interim report has been issued summarizing the experimental studies, "Dejacketing of Zircaloy Clad Fuel Elements With Ammonium Fluoride Solutions," HW-49633 by J. L. Swanson. Further studies will provide quantitative information on the distribution of U and Pu into the cladding waste solution as well as possible steps for holding these quantities at desired levels.

Flurex

During the month a "trench-cathode" Flurex cell was completed and tested. Exposed cation and anion exchange membrane surfaces are 11-inches high and 2-inches wide with the feed chamber between about 1/2-inch thick. The anode is a platinum plate parallel to and about 1-1/4 inch from the anion membrane. The cathode consists of three mercury-filled trenches situated one above the other and parallel to the cation membrane. Mercury level in the bottom trench is about flush with the bottom of the cell. All three trenches are provided with plexiglass stirrers. This

particular cathode arrangement was used in order to obtain a more uniform current density in the membranes than is possible with a single mercury-pool cathode in the bottom of the cell.

A special feed cell divided into five compartments was used in runs made to study the membrane current density distribution when using all or only one of the cathode trenches. Using solution compositions approximating those anticipated for a production Flurex cell, current density through the top feed compartment was 42 per cent of that through the bottom compartment when only the bottom trench was used as cathode. When all three trenches were used variation in the current density through the five feed compartments was generally less than 10 per cent. Membrane current densities observed agree well with calculated values based on solution and membrane conductivities reported previously. These observations lend confidence to calculations of cell performance vs. cell geometry based on measured conductivity of individual cell components.

Observed current efficiency (based on dried NH_4UF_5 product) for the trench-cathode cell was about 45 per cent when the mercury was not stirred compared to 93 per cent when stirred. These results demonstrate again the need for renewal of the mercury surface. Future runs in the cell will determine the degree of agitation required and will test several proposed methods of obtaining agitation.

Performance of the trench-cathode cell has been highly satisfactory and it is anticipated that some form of trench cathode will be included in design of the 321 Building pilot-plant-scale Flurex cell.

As part of a program aimed at determination of membrane useful life under operating conditions, the effect of time, temperature, and solution composition on pertinent properties of the membranes is under study. Initial experiments involved exposure of anion membranes (Nalfilm 2 and Permutit 3148) to nitric acid of various concentrations simulating possible anolyte compositions (0.1, 0.5, and 1.0 M). The solutions were maintained at 90 C and conductivity, physical dimensions, and permselectivity of the membranes were determined at various exposure times. Observations made after 80 hours exposure may be summarized as follows:

1. Resistance of the Permutit membrane decreased with exposure time to all three solutions, becoming about half its original value. Also the degree of permselectivity under a given set of conditions decreased with exposure to all three solutions, dropping from 0.9 to about 0.75. (Permselectivity is defined as the fraction of the current carried through the membrane by the anion, in the case of the anion membrane; and as the fraction of the current carried through the membrane by the cation, in the case of the cation membrane.) Change in area of the film was nil although an increase in thickness of about 10 per cent occurred.

2. Dimensional changes in the Nalfilm 2 membrane were absent. In 0.1 M HNO_3, resistance decreased to about 25 per cent of original while in 0.5 and 1.0 M HNO_3, resistance increased to nearly 10 times the original. Permselectivity dropped from 0.90 to about 0.55 in 0.1 M HNO_3 and to about 0.7 in 0.5 and 1.0 M HNO_3. Extended use of this film in HNO_3 at elevated temperature appears impractical due to increased resistance and/or decreased permselectivity.

Attempted permselectivity studies with Ionics-CR-61 cation membrane revealed that the resistance of this membrane increases rapidly in use to a value many times the initial value under operating conditions approximating those for Flurex. Similar difficulties occurred in attempts to obtain current efficiency data for Nalfilm cation membrane. No explanation for this unexpected behavior of these membranes has been found. Similar resistance variations have not been observed with Permutit cation membrane.

Transfer of water through the anion membrane of a Flurex cell is dependent on the concentration of uranium in the feed compartment and ranges from 0.17 to 0.35 g H_2O per 1000 coulombs of current passed as uranium concentration is decreased from 1.1 to 0.1 molar.

CONTINUOUS METAL DISSOLUTION

Several runs were completed during the month in the two-inch-diameter continuous countercurrent tower dissolver using 60 per cent nitric acid as feed. Preliminary results are summarized in the following table.

Feed = 60% HNO_3 + 0.005 M $Hg(NO_3)_2$

Product Composition			Type of Slugs	Diss. Rate Lb. U/Day/Lb. Heel
UNH, M	HNO_3, M	HNO_3/UNH		
2.3	4.0	1.7	Unjacketed	1.6
3.0	1.7	0.6	Unjacketed	1.6
3.5	1.1	0.3	Unjacketed	1.2
2.3	3.6	1.6	Jacketed	1.8
2.4	2.5	1.1	Jacketed	1.1
2.5	2.0	0.8	Jacketed	0.8

Reduction of the residual acidity in the product appears to have a larger adverse effect on the dissolving rate of jacketed slugs than of unjacketed slugs. The results are encouraging and indicate high dissolution rates if some acid can be tolerated in the dissolver product. Further tests at lower residual acidity are planned.

CAUSTIC SCRUBBER STUDIES

The six-inch-diameter bubble cap caustic scrubber with six trays on two-foot spacing was operated to measure efficiencies of iodine removal. A concentration of 500 ppm iodine in air was used as the feed vapor. Efficiencies greater than 99.85 per cent were obtained consistently with 25, 15, and 5 per cent caustic scrub solutions. No decrease in efficiency occurred when synthetic coating waste solution was substituted for sodium hydroxide solution.

After 168 hours of continuous operation at nominal plant rates, no plugging of equipment or lines was detected. Analytical results, though incomplete, indicate almost complete conversion of the sodium hydroxide to sodium bicarbonate and carbonate.

[redacted]

Improved Reactivity - UO_3

Among the various methods investigated for increasing the reactivity (in the fluorination process) of UO_3, the most effective treatment developed so far involves fluidized-bed reduction of the trioxide with hydrogen to produce UO_2 which is then reoxidized with air in another fluidized-bed to produce U_3O_8. This material made in this manner has satisfactory reactivity regardless of the quality of the starting UO_3 material. A study was initiated to establish the magnitude of the economic incentive for carrying out pilot-scale development work for such processing. Capital expenditure at Hanford would amount to about $450,000 after being credited with construction expenditures not required at Paducah. Annual operating cost savings of $40,000 (Paducah savings less Hanford operating costs) were shown. In the report of this study, HW-50081*, it was concluded that a full-scale process could not be justified at this time but that consideration should be given to pilot-scale development without priority over present programs.

Anion Exchange Process for Plutonium Recovery

An informal report, HW-49524, entitled, "Tentative Flowsheet for Recovery and Concentration of Plutonium by Continuous Ion Exchange," by J. L. Ryan, was issued to guide 234-5 Development Operation in demonstration of this process in the laboratory-scale continuous ion exchange unit. The flowsheet uses a feed solution containing 7.2 molar nitric acid and operating at a flow rate of 28 mg $Pu/cm^2/min$. The elutant is 0.35 molar nitric acid at a flow rate designed to yield a product concentration of 50 g Pu/l. The operating temperature of both extraction and stripping columns is 50 C.

Dissolution of Uranium by Bismuth Bromide

Preliminary experiments were conducted to determine the reaction characteristics of uranium and bismuth bromide, a reaction proposed by R. H. Moore in HW-48503 for the pyrochemical dissolution of uranium. The details of this brief study may be found in HW-49781, "The Reaction of Uranium and Bismuth Bromide - A Preliminary Investigation" by H. T. Hahn. The following conclusions were drawn: (1) the reaction occurs rapidly in the vicinity of 400 C with a dissolution rate greater than 0.32 grams per minute per square centimeter, (2) the product is a solid at the reaction temperature when the ratio of bismuth bromide to uranium is 1.6 to 1 or less; the conditions for product solubility are unknown, (3) the reaction apparently produces uranium tetrabromide rather than the tribromide,and (4) the reaction proceeds smoothly without violence and could undoubtedly be adapted to the large scale dissolution of uranium metal.

WASTE TREATMENT AND BY-PRODUCT RECOVERY

Neptunium Recovery

Data have been obtained on plant samples which define the path of neptunium in the Purex plant. They show that the fraction of Np appearing in the uranium product

*HW-50081, "Uranium Oxide Activation Cost Study" by R. W. McKee, April 23, 1957.

since the first of the year is sensitive to solvent characteristics. Correlations of plant operation with laboratory experiments support a hypothesis that the extractibility of neptunium in the plant operation is due to degradation of the solvent to form compounds which preferentially extract neptunium.

Analyses made of the major Purex streams, and the results for samples taken on three different dates are shown in Table V.

TABLE V

DISTRIBUTION OF NEPTUNIUM IN THE HANFORD PUREX PLANT

Stream	Percent of Feed Neptunium		
	March 22	April 5	April 12
1AF	64	82	NA*
1AW	11	44	4
2DF	--	41	39
2DW	--	41	19
2EUC	19	10	25
1BP	--	Negligible	NA*

* Data not currently available

It is noted that a major fraction gets past the HA-HC cycle. It then splits into essentially all of the aqueous streams. However, only negligible amounts are found in the 1BP or in the plutonium product, as would be expected based on the extractability of neptunium(IV) and the high nitric acid concentration in the 1B column.

Variation of the concentration of neptunium in the uranium product with time is shown in Table VI. The dates given are equivalent Purex dates, i.e., in the case of the car lot samples these are the date of oxide sampling less five days. On the basis of an average exposure of 650 MWD/T and a value of 0.0036 for the Np/Pu ratio, the calculated feed neptunium is equivalent to 1.5 grams per ton of UO_3. The percentages of feed neptunium in the product are based on this value and are only approximate. The three samples of 2EUC are essentially "grab samples" and would be expected to show more variation than the oxide samples.

TABLE VI

NEPTUNIUM IN PUREX URANIUM PRODUCT AS A FUNCTION OF TIME

Date	Car No.	gm Np^{237}/T UO_3	Percent Feed Neptunium
1/31	16	0.18	12
2/4	17	0.05	3
2/21	509	0.51	34
2/28	510	0.84	56
3/5	511	0.82	55
3/11	512	0.70	47
3/17	22	0.87	58
3/18	513	0.75	50
3/22	2EUC	0.3	20
4/5	2EUC	0.2	13
4/2	2EUC	0.4	27

It will be noted that the concentration of neptunium in the uranium product increased markedly about February 21, remained high until March 18, and then declined. This behavior coincided with a change in the solvent wash procedure. During the period February 7 to March 17, the "front end" (I00) solvent received a batch carbonate wash followed by a two per cent nitric acid scrub in the I0 column. Prior to this time, a double carbonate wash was employed. This was reinstituted on March 18 and is still being used. A trend toward higher plutonium losses and poorer ruthenium decontamination was also noted during use of the nitric acid treatment, and was one reason for its abandonment. These results strongly suggest that some solvent degradation product is responsible for all of these phenomena, and the following laboratory experiments support this view.

A 30 per cent TBP-Shell Spray Base solvent was degraded by digestion for 48 hours with 6 M nitric acid containing 0.1 M nitrite, and the extraction coefficients of neptunium (IV), (V), and (VI) into this solvent from 2 M nitric acid were then determined both at room temperature and at 45 C, the approximate current temperature of Purex plant operation. The results are shown in Table VII with the corresponding values for untreated solvent in parenthesis. The extractability of both the (IV) and (V) states is increased by factors of 6 to 30, whereas the (VI) is not appreciably effected. In other experiments, carbonate washed plant I00 solvent gave neptunium(V) extraction coefficients from 2 M nitric acid of about 0.1 and 0.45 at room temperature and 45 C, respectively, and 200 plant solvent gave 0.1 and 0.3. These numbers can be compared to values of about 0.02 with laboratory solvent and are adequately large to account for the observed plant behavior of neptunium. Dibutyl phosphate, on the other hand, when present to the extent of 10^{-4} M did not appreciably effect the extraction of either neptunium(IV) or (V), suggesting that degradation of the diluent is responsible for the observed effects.

TABLE VII
EFFECT OF DEGRADED SOLVENT ON NEPTUNIUM EXTRACTION

30% TBP-Shell Spray Base degraded by 48 hours digestion at 70 C with 6 M HNO_3-0.1 M nitrite. Extraction coefficients from 2 M HNO_3.

Neptunium Oxidation State	E_a^o R.T.	E_a^o 45 C
IV	13 (1.7)*	7 (1.1)
V	0.4 (0.02)	0.6 (0.02)
VI	8 (12)	6 (9)

* Paranthetic numbers are controls with untreated solvent.

Workers at the Savannah River Plant have attributed the extraction of neptunium to a nitrite catalyzed nitric acid oxidation of neptunium(V) to (VI). In an experiment to check this idea, a 2 M nitric acid solution containing 0.1 M nitrite was agitated with 30 per cent TBP-Shell 2342 and the distribution coefficients of neptunium (initially V) followed as a function of time. At 45 C, the gross neptunium extraction coefficient increased from a value of 0.34 at ten minutes to 0.83 at one hour versus a constant value of about 0.02 in the absence of nitrite. The effect at room temperature was less marked. While these results taken by themselves, would seem to indicate oxidation to the extractable (VI), an explanation more consistent with the other work would be that the nitrite is bringing about a degradation of the organic phase.

Thus, increasing the temperature from 25 to 45 C was found to decrease the extraction coefficients of neptunium(IV), (V), and (VI) by about one-third when employing laboratory solvent. The presence of sulfate in the aqueous was found to markedly decrease

the extractability of neptunium(IV) and would seriously interfere with any solvent extraction process based on extracting neptunium(IV). The concentration of sulfate should be kept as low as possible.

Manganese dioxide, particularly co-formed, has been previously reported to be effective for oxidizing neptunium to the (VI) state, and column evaluations are in progress. Additional experiments have now shown that sodium bismuthate and lead dioxide are equally effective, as was sodium bromate (previously evaluated at ORNL and rejected for corrosion reasons). Persulfate was ineffective due to unfavorable kinetics.

Appraisal of the situation leads to the view that the use of an oxidizing agent in the first solvent extraction cycle is the most positive means for forcing the Np to accompany the Pu and U at this point. It is relatively well established that conditions in the partition column (1B) will drive the Np to the IV state and that it will follow uranium to the second solvent extraction cycle. Introduction of sulfate at this point is expected to force the Np with second cycle waste. This waste can be processed through ion exchange to separate Np. The balance of the waste will be back-cycled to the first solvent extraction cycle.

Ion exchange studies have shown that semicarbazide is a satisfactory reducing agent for neptunium in high acid (8 M) solutions and that it gives almost as high distribution ratios onto Dowex-1 as are obtained with ferrous sulfamate. Column runs are in progress but are limited to a very small scale inasmuch as only 100 milligrams of neptunium-237 are available. Reasonably good breakthrough and elution curves have been obtained in columns containing 0.1 ml of resin; however, there is evidence that channelling and kinetic factors in these small columns may cause erroneously low apparent capacities.

An interim status report on the neptunium recovery work is in preparation and will soon be released as HW-49825.

Concentration of Np-237 in Irradiated Uranium

Analyses of Purex feed (HAF) solution from 730 MWD/T metal yielded a Np-237/Pu ratio of 0.004. An uncertainty of as much as ± 20 per cent is inherent in the counting statistics. However, the value agrees well with 0.0036 computed from nuclear crosssections and a more rigorous calculation by the Theoretical Physics Operation.

WASTE TREATMENT STUDIES

Cesium Isolation and Packaging Facility

The first engineering flowsheet defining a batch-type calcination process to convert an aqueous slurry of zinc-cesium-ferrocyanide to a dry cesium chloride product was prepared. Laboratory experience has shown that the presence of nitrate in the influent slurry introduced a potential hazard to the calcination step. The flowsheet will be modified to eliminate nitrate before calcination.

Semiworks Waste Self-Concentrator

During the month, 378 liters of condensate from the boiling waste concentrator were collected and cribbed, reducing the liquid level in the tank to approximately 9-1/2 feet. This corresponds to 22 per cent of the original volume charged to the tank. (If tank contents were homogeneous, sodium ion concentration would be approximately 23 M).

No pressure "bumps" have been recorded since March 21. However, the condensate rate has evidenced a definite boiling cycle. Every 12 to 18 hours, the condensate rate peaks at about 24 ml/min. with the 1/2-inch vapor valve open and at about 50 ml/min. with the one-inch vapor valve open. Between peaks, the condensate rate ranges from 0 to 6 ml/min. The tank temperature profile also reflects the 12 to 18 hour cycle.

During the last month, tank temperatures below the liquid surface have steadily gained from 13 to 17 F, the largest gain occurring at the bottom. The actual temperature range from 259 F one foot beneath the liquid surface to 302 F six inches off the tank bottom.

An attempt was made to determine the liquid and sludge consistency by turning the manual agitator paddles which were installed in the tank before filling. Normal friction in the system made it impossible to detect any difference in the torque required to turn the top four paddles. Three of these paddles are immersed in liquid while the upper one is "free" in air. Evidence that the sludge has set up like "cement" was obtained when a fifth agitator in the sludge layer (approximately one foot off tank bottom) was "frozen" solid. The paddle did not break free when a force great enough to break the 9/16-inch stainless steel rod was applied. Calculations indicate that a force of greater than 500 lb./sq.in. was exerted on the sludge by the paddles. Although three of the agitator paddles were beneath the liquid surface, no significant changes in temperature, pressure, or boil-off rate were noted as a result of turning the paddles. Actual speed of the paddles was a jerky one to two revolutions per minute for two to five minutes.

Special Geological Studies

Drilling on the fixed-price portion of the CA-700 (FY-1957) Chemical Effluents Technology drilling program by the Hatch Drilling Company began April 8th. In approximately two weeks of drilling three wells were completed and two more under way, about two weeks ahead of the contract requirements. The Geological Survey drillers bettered their drilling progress and are currently less than 150 feet behind schedule. Probable completion of the CA-700 project for an estimated cost 28 per cent less than originally scheduled is attributed to competitive bidding, to improvements in drilling techniques as employed by fixed-price contractors, and to the successful efforts of the Geological Survey drillers to increase performance and decrease costs.

Data recently procured further indicate the desirability of testing the use of rotary drilling equipment at Hanford. Savings up to one-half the present costs appear possible, moreover drilling rates up to five-times the present speeds are indicated. Negotiations between the Atomic Energy Commission and Geophysical Service, Inc. of Dallas, Texas, for the proposed geophysical evaluation study continued. Evaluation of the rotary drilling techniques as used by that company will further determine the desirability of use of rotary equipment here.

Well 299-W15-5, drilled to basalt at a depth of about 530 feet, encountered subnormal, non-artesian water beneath the two clay horizons of the uppermost part of the lower Ringold formation for more than 100 feet of depth. The data, from the east side of a deep structural basin in upper Cold Creek Valley, confirm similar data obtained in 1948 in a well toward the west side of that basin nearly three miles away. The subnormal level indicates no appreciable recharge from deeper artesian aquifers in the basalt and no appreciable hydraulic continuity with shallower ground waters there. Storage of large volumes of wastes in this deep Ringold aquifer may be feasible.

Disposal to Ground

An investigation of the possibility of direct disposal of aluminum coating waste to the ground was started concurrently with the study of gelling of the material. The

preliminary results of a soil column test with a sample of supernatant liquid (aluminum coating waste) from the 105 C tank were as follows: essentially none of the 7.5 μc/ml of Ru^{106} was adsorbed by the soil, the concentration of Cs^{137} was reduced from 4.1 μc/m. to $<1.2 \times 10^{-4}$ μc/ml, and the concentration of Co^{60} was reduced from 1.2×10^{-2} μc/ml to 2.1×10^{-3} μc/ml at one column volume of effluent. Plutonium and uranium were adsorbed sufficiently to permit disposal to the ground, but the preliminary analytical results for Sr^{90} were not sensitive enough to evaluate the extent of adsorption of this radioisotope by soil. This test represented the first instance of Co^{60} adsorption by soil, however the adsorption was still insufficient to permit direct disposal to the ground based on present limits. Samples of aluminum coating waste from tanks 106-T and 109-U were obtained for additional experimental work.

A laboratory soil column test was begun with A-8 waste (Purex tank farm condensate) to estimate the "crib life" of the A-8 crib for the higher activity density wastes, which are being produced under present operating conditions. The activity density of current A-8 waste is approximately 100 times greater than that produced six months ago, however this is probably due, at least in part, to the reduced volumes of condenser cooling water.

Approximately one million gallons of TBP scavenged waste supernate having a Co^{60} concentration greater than 4×10^{-4} μc/cc were discharged to the 216-BC trenchsite during the month. This brings the total volume of scavenged waste disposed on a specific retention basis at this site to 11.5 million gallons. Remaining unused trench space will accomodate 5 million gallons of non-cribbable supernate.

In-farm scavenging operations at C Farm were started on March 31. The first batch of settled supernate (9-112C-102C) was sampled and analyses should be available by the end of the month. Analytical and soil column testing results will determine the suitability of disposing of this waste to the 216-BC cribsite on a test basis. Chemical Processing Department was requested to delay disposals to the 216-BC cribsite until test wells can be drilled and hydrological testing performed before the wastes enter the regional ground water. An outline of proposed geological and hydrological tests and monitoring and analytical requirements concerned with the test disposal of high Co^{60} scavenged waste at the 216-BC cribsite was under preparation.

Recommendations were made to Chemical Processing Department for the disposal of 21,000 gallons of contaminated organic solvent stored at the Metal Recovery Plant. Disposal, on a specific retention basis, to a trench to be located west of U-Plant and immediately adjacent to a site which received organic waste several years ago was recommended.

Observation Wells

The addition of new monitoring wells in the vicinity of the BC cribs and trenches permitted a more detailed analysis of the ground water elevations in this area. This analysis revealed the presence of a small ground water mound beneath this site. This mound can only be caused by recharge of the ground water by liquids disposed to these facilities. The mound complicates the selection of monitoring well sites for the special disposal test proposed for these disposal structures.

Samples of ground water obtained from wells adjacent to the 216-S-1 and 2 cribs contained detectable concentrations of Sr^{90}. This is the first time Sr^{90} has been

detected in the ground water at Hanford. These cribs received large volumes of D-1 and D-2 wastes from the Redox plant until they were replaced by the 216-S-7 crib over a year ago. The 216-S-1 and 2 cribs were abandoned when soil column tests of the wastes being discharged to the site demonstrated very poor strontium removal. The wastes were discharged at a low pH (2-4), conditions not suitable for strontium removal by soils; such waste streams are now neutralized before discharge to the ground. The ground water samples were found to have pH 7.5-8.0, at which strontium removal should be readily achieved. It is felt that the strontium contamination cannot move far in the ground water without being removed by the soil under these conditions. The highest Sr^{90} concentration found in the ground water was 1×10^{-6} uc/cc, or 2-1/2 times the Handbook 52 MPC for drinking water. The occurrence of radio strontium in the ground water at the measured pH indicates that the soil beneath the crib is still draining although no liquids have been discharged to the site for many months.

Process Development

The investigation of the use of ion exchange resins for the disposal of condensate wastes was continued. The extremely high affinity of the resins and the relatively low concentration (on a weight basis) of radioisotopes continued to interfere with attainment of reliable breakthrough data. Although such efficient removal of radioisotopes appeared at first glance to assure the successful application of ion exchange resins, preliminary estimates indicated that an extremely high resin column efficiency will be required to compete with disposal to the ground on an economic basis because of the deep soil profiles of the Separations Areas plateau. Samples of A-8 waste undiluted by condenser cooling water were obtained and additional Sr^{90} added. Experiments were begun to obtain breakthrough data for Sr^{90} using this waste. Preliminary attempts to elute Sr^{90} from Duolite C-3 resin indicated sulfuric acid or sodium chloride solutions as possible eluting agents. The sodium salt would be preferable since the resin then would be regenerated to the original sodium form during the elution step. Elution data will be necessary to determine whether it is more economical to discard or regenerate resin which has been loaded with radioisotopes from A-8 waste.

Gelling of Wastes - Field Work

It was demonstrated in the laboratory that a Vanton pump will provide sufficient mixing of a sodium silicate synthetic coating waste solution to form an aluminosilicate gel. The 1/3 gpm positive displacement pump provided suction on two containers, one containing 20 per cent sodium silicate, the other synthetic-coating waste. The solutions were blended at the pump inlet, mixed in the pump chamber, and discharged as a milky liquid which set to a gel in 2 - 3 minutes. Although there was no evidence of plugging in the lines or pumps, some difficulty was experienced in attempting to maintain flow control so that the solutions blended in a 2:5 silicate to waste volume ration.

Preliminary planning for field tests indicated that the most satisfactory method for mixing the streams and disposing of the gel will be realized by pumping each stream into a common mixing nozzle or chamber located near the end of the discharge line.

A four foot long, 6-inch diameter lucite column partially filled with soil and topped with a one foot thick layer of aluminosilicate gel is being set up to evaluate

moisture loss to the soil due to compaction of the gel and to blotter effects exerted by the soil. Data obtained from this evaluation will be used to determine the length of column(s) necessary to evaluate loss of moisture from greater gel bed depths which would be encountered in plant scale disposals.

The economics of gelling vs. other methods of obtaining tank space was studied. Using actual costs of the waste scavenging process as a basis and applying the necessary adjustments it was estimated that coating waste may be gelled, discharged into an excavation, and covered at a cost of eight to nine cents per gallon. While being about three times as expensive as direct disposal to the ground, this process will be about two cents per gallon less expensive than evaporation and about eleven cents per gallon less expensive than tank storage.

ANALYTICAL AND INSTRUMENTAL DEVELOPMENT

Mass Spectrometry

Work was continued on the thermal emission mass spectrometer with most of the effort concentrated on the scanning method instead of the pulse counting method. Precision of the U-235 to U-238 ratios obtained by the scanning method was improved nearly ten-fold to about ± 1.5 per cent. The improved performance is attributed to the careful repositioning of the beam deflecting magnet which resulted in a narrower beam width of 10.5 mils. Additional improvements in the scanning method were made by modifying the magnet power supply to scan in both forward and reverse directions. An averaging of the results from both the forward and reverse scans eliminates the corrections for the gradual but noticeable change in the ion beam current with time. Further improvements in results will be realized when modifications to the micro-microammeter are made to remove the transients between range changes which tend to mask the peaks.

Controlled Potential Coulometry

It has been demonstrated that the plutonium concentration of a solution can be determined by titration from the three to the four valence state with a controlled potential coulometer. Preliminary precision measurements indicate that the method will be capable of obtaining the desired precision of ± 0.2 per cent (95 per cent confidence level). The range of 1 to 40 mg of plutonium has been investigated, and about four mg was chosen as the optimum sample size. Repeat titrations of a four mg sample (re-oxidation coulometrically in situ between titrations) resulted in a precision of ± 0.1 per cent, but titrations of separate samples showed a precision of ± 0.4 per cent. The optimum oxidation potential has been found to be ± 0.1 to 0.08 V with respect to a standard calomel electrode while the optimum reduction potential is about - 0.2 volts. These are the minimum potentials which will completely and reproducibly oxidize and reduce the plutonium in the citrate medium being used. Any substance which will reversibly change valence state between these two potentials will act as an interference to the estimation of plutonium by this technique.

Analysis by X-ray Fluorescence

The x-ray fluorescence method is useful for quantitative analysis of individual elements. The sample is irradiated by monochromatic 50-KV x-rays which are absorbed by each element and re-emitted as fluorescent x-rays having wave lengths characteristic of the atomic number. The wave length can be accurately measured with aid

of a diffracting crystal and goniometer, and the intensity, which is a function of the concentration of the element, can be readily determined. With the present detector, an argon-filled Geiger-Mueller tube, and a three inch sodium chloride analyzing crystal, it was possible to determine elements in the range from iron (at. No. 26) to silver (at. No. 47) at a concentration of 50 mg/l with a precision of about ± 5 per cent. The elements from Hg (at. No. 80) to the end of the periodic table could be determined at a concentration of 100 mg/l with the same precision. Ten milliliter samples were used in these direct measurements; however, by evaporating the samples to dryness on a small disc of filter paper, a ten-fold increase in sensitivity was obtained, thus lowering the minimum determinable amount to 5 and 10 mg/l, respectively, for the light and heavy groups.

Contact Alpha Counter

The life test of a number of phosphors of different configuration is continuing. After five weeks, no major attack appears to have taken place, although some very small blisters have appeared on the Teflon surface of several of the phosphors. The small blisters only appear on the Teflon that is directly covering the zinc sulfide. The jig for making phosphors was modified to prevent the somewhat excessive flow of fluorothene previously experienced and to give a somewhat better dimensional stability to the phosphor material. Some 50 phosphors recently made with the modified equipment will be tested for uniformity of response to a fixed alpha source to evaluate the present method of phosphor production.

The proposed Purex Phase II Flowsheet calls for an 8 gram per liter plutonium concentration in the 2BP stream, which is higher than originally anticipated by a factor of four. Additional testing with the alpha counter covering this concentration range will be made since completed tests only include concentrations up to 6 grams per liter.

Interface Detector

A liquid interface detector-controller using a float-driven armature in a stationary coil has been fabricated for Facilities Engineering for prototype testing in the Purex 1A Column (Dwg. H-2-56729). The float and controller-transmitter unit were calibrated in the Purex Instrument Shop. The float has a 5-1/2 inch travel from zero to full scale and responds well to a 0.12 density difference between phases. Consideration is being given to prototyping a second unit in the 10 column.

Plutonium Resin Column Controls

Reservoir Level Indicator. The resin level indicator has operated satisfactorily during plant cold runs using a cation exchange resin. Tests are underway to determine if the unit can be modified to operate using an anion exchange resin in the column. The conductivity difference between resin and solution with the two types of resins requires conductivity measurements of different orders of magnitude. The anion resin in the reservoir will probably be in equilibrium with 7 to 8 molar nitric acid, whereas the cation resin is in equilibrium with demineralized water.

"C" Column Acid-Water Interface Detector. The acid-water interface detector operated satisfactorily during plant cold runs with cation exchange resin. This instrumentation will also have to be reevaluated for use with an anion exchange resin. With cation resin, the instrument detects the difference between water and dilute acid, whereas with an anion resin it must detect the difference between two levels of rather concentrated acid.

Absorptometer for Plutonium Loading on Resin. The absorptometer unit for detecting the concentration of plutonium on the resin was tested (with uranium) on the prototype column in the 321 Building. Preliminary tests revealed that the calibration data based on equivalent lead absorbers were in error by as much as 200 to 300 per cent. The unit was returned to the laboratory for recalibration using uranium-loaded resin. The apparent discrepancy using lead absorbers will also be studied in greater detail but will require more time.

Purex AAA (F-3) Sampler Mock-Up

A design proposed by Facilities Engineering for the F-3 gamma monitor at Purex was tested for operability in the 321 Building. The design incorporates an "in-cell" degasser and jet. It does not require valves in the process lines and allows the sample cell to drain by shutting off the air to the jet. The design, as prototyped, was not operable. However, by changing line sizes and minimizing sample holdup volumes, the system could be made to operate satisfactorily. At the completion of these tests, the changes incorporated in the design will be recommended to Facilities Engineering.

Redox 1AFS (F-1) pH Prototype

As a result of piping changes, the buffer and rinse solutions now flow by gravity through the pH cell. A problem still remains with sampling the process stream which is thought to be due to restrictions in the valves in the sample manifold. Valves are being modified to improve their flow characteristics and will be used if their performance is acceptable for this service; otherwise, a valve-free manifold will be installed.

During periods of satisfactory sampling, the monitor gives pH data which compares favorably with the limited laboratory results.

EQUIPMENT DEVELOPMENT

Redox Spare Pump (Bingham Deepwell Turbine)

A spare deepwell turbine pump equipped with glass bearings operated about 200 hours pumping dilute simulated Redox 1AFS solution (Redox Flowsheet No. 5). The test was discontinued when the motor shaft seized. The glass bearings were in perfect condition. The ball bearings in the motor were frozen and the motor windings were burned. Failure was apparently caused by lack of lubrication in the motor bearings although grease was present in the housings above the bearings.

Valves

"Valvair" Solenoid Valve. This valve has operated 207,000 times (16 operations per minute) opening and closing against 83 psi air. This valve has given better service than other solenoid valves tested.

Hills-McCanna Saunders-type Valve. A spare Purex Plant Hills-McCanna Saunders-type valve was equipped with a Teflon coated neoprene diaphragm molded in the closed position. The Teflon and neoprene were badly cut and cracked after 230 forceful closures. Also, the threads on the small (8-32 threads) screw molded into the diaphragm were stripped. Super Dylan (Ziegler Polyethylene) diaphragms will be tested when they are available.

Jamesbury Ball Valve. A pneumatically operated plug-type valve has operated for 120 hours (115,000 operations at 16 operations/minute). The valve was closing against 100 psig water requiring 20 psig air for operation. After 2800 operations closing against water containing ion exchange resin, the valve started sticking. The cylinder of the air cylinder was scored and neoprene "O"-ring" on the end of the piston was destroyed. The presence of ion exchange resin in the system did not necessarily cause the valve failure.

Materials of Construction

K-1047 Silicone Rubber, milled by Huntington Rubber Company from a raw gum manufactured by Dow Corning, was tested for chemical compatibility and the effects of irradiation on chemical compatibility.

This elastomer failed in 50 per cent caustic soda by hardening and spalling of the surface. It dissolved in Recuplex CAX and Purex HAX. Only minor shifts in these tendencies were caused by irradiation. Dosages of 10^7r and over caused some hardening. Immersion in 10 per cent nitric acid for 35 days seemed to make little change but immersion in distilled water for the same time caused a noticeable softening. There was no change in linear dimension noted on either of these two samples.

Immersion for 35 days in 60 per cent nitric acid caused a marked increase in hardness which decreased slightly with increased irradiation. There was little change in length noted, 12 per cent for the 10^8r sample, in 60 per cent nitric acid.

The samples tested in hexone and in carbon tetrachloride both swelled markedly, approximately 30 per cent in hexone and 40 per cent in carbon tetrachloride. This swelling was accompanied by a reduction in hardness. Both changes decreased upon increasing radiation dose.

LS 53 Silicone Rubber, milled by Huntington Rubber Company from a raw gum manufactured by Dow Corning, was tested for chemical compatibility and for the effects of irradiation on chemical compatibility.

LS 53 rubber failed in 50 per cent caustic soda by surface deterioration. The material dissolved in Purex HAX. It swelled severely and lost strength in Recuplex CAX and Hexone but there was no indication of dissolution. Changes in dimension and hardness in 10 per cent and 60 per cent nitric acid, carbon tetrachloride and distilled water were negligible. Radiation dosage up to 10^8r caused no noticeable changes in the chemical compatibility of this material but it did cause the material to lose tensile strength.

Seilon DP and Seilon Glare-Ez, transparent vinyl-type plastic sheet material manufactured by Seiberling Rubber Company was tested by static immersion at room temperature for 28 days. Both these materials successfully withstood immersion in 60 per cent nitric acid, 50 per cent caustic soda, carbon tetrachloride, Recuplex CAX, Purex HAX, and distilled water. The material delaminated after less than 24 hours in hexone.

Seilon DP is furnished in a standard green tint and Seilon Glare-Ez in a standard blue-grey tint. Crystal clear sheet is not available since tinting is required for light stability.

Corrosion Studies

Corrosion Rates by Activation Analysis Techniques. Several stainless steel coupons irradiated for use in corrosion studies are now being exposed to various corroding media. Corrosion rates based on gross gamma determinations are two- to three-fold lower than rates determined from weight loss under similar conditions. This discrepancy is currently thought due to preferential dissolution of iron which has a lower specific activity than chromium in the irradiated samples. Gamma scan determinations now in progress may provide an explanation.

Redox Waste Storage. The first set of samples from the 107-SX tank was removed April 3, 1957. The operation went smoothly with the exception of the initial freeing of the lead radiation plugs. Apparently, corrosion products from the mild steel pipe had flaked off from above and deposited around the shoulder of the plug making removal of the plugs somewhat difficult. It is quite possible that future removals will be more difficult because of this. The samples were delivered to Radiometallurgy for examination.

Effect of Dichromate and Sulfate on the Corrosion of A55 Titanium in Nitric Acid. The corrosion rate of A55 titanium in boiling 65 weight per cent nitric acid was not affected by dichromate in concentrations from 0.01 to 5 g Cr/l. Sulfuric acid increased A55 titanium corrosion rates in boiling 65 weight per cent nitric acid by factors of 3 to 5 at 0.01 M $SO_4^=$ and 10 to 20 at 1 M $SO_4^=$.

Effect of Fe^{+3} on Corrosion of 304L Stainless Steel in HNO_3. Ferric ion had no effect on the rate of corrosion of 304L stainless steel in boiling 65 weight per cent nitric acid at concentrations from 0.01 to 1 g/l. At 5 g/l, the corrosion rate was increased by a factor of 7. The effect of ferric ion on corrosion of stainless steels by nitric acid is apparently similar to that of Cr(VI), i.e., there is a critical concentration below which corrosion acceleration is negligible.

Mock-up Heat Exchanger Studies. After 1.75 months exposure to boiling 60 weight per cent nitric acid at a steam temperature of 175 C, a 304L bayonet suffered a 14 per cent weight loss while an A-70 titanium bayonet lost only 0.035 per cent of its weight. Preferential attack near welds was very apparent on bayonets of 446, 310 Cb, and 16-2 manganese substitution stainless steels exposed to 60 weight per cent nitric acid at steam temperature of 145 C.

MISCELLANEOUS

Hot Semiworks Maintenance Activities

The maintenance program at the Semiworks is 85 to 90 per cent complete. Process piping work is 85 per cent complete.

The feed centrifuge, G-6, was dismantled, cleaned, assembled, and tested. Flush lines for improved decontamination were added. New thick walled (3/4-inch pipe) rings were placed in the No. 1 acid concentrator tower and revised packing supports were installed. The corroded rings were removed from the No. 2 acid concentrator tower and a layer of thick rings were added in the bottom section of the tower. New one-inch rings with a Huey test corrosion rate of 0.0015 ipm were used in the remainder of the tower. The wall cover skirt (secondary seal on the wall) was completed. This concludes the work on the stainless steel floor in A Cell except for

final leak testing. Revisions on the remote connector pan for the A Cell pumps were completed. The unit was installed in the cell and repiped. The permanent lighting system for A Cell was placed in service. Improved visibility and safety has resulted.

Annular 2A Column. Fabrication of the annular column is proceeding on schedule. The contacting section will be ready for tie-in upon completion of the following items:

1. Fabrication and installation of feed distributors.
2. Fabrication and installation of samplers.
3. Fabrication and installation of "Plexiglas" windows for four observation ports.
4. Welding end flanges on 16-inch shell.
5. Final assembly.

Work is in progress on the first three of these items and all are expected to be finished on or before May 17. Tie-in is scheduled for completion on May 31.

Anion Exchange for 1WW Rework. The test unit is now complete and operation should be underway in May.

Purex 2A Column Capacity Tests. Erection of a 6-inch-diameter, 10-foot-long glass column is about 75 per cent complete. Processing capacities using the Purex Phase II flowsheet and possibly a new "ultra-low-acid" flowsheet are to be determined.

Operation of the test unit is expected to commence during the week ending May 5.

3000 PROGRAM - WEAPONS

In support of Plutonium Metallurgy studies, emission spectrographic methods are being adapted for measuring both zirconium (from crucibles) and titanium at the 1 per cent level in plutonium. Zirconium is being separated from plutonium by anion exchange while separation is unnecessary for titanium. Working curves are being prepared.

4000 PROGRAM - REACTOR DEVELOPMENT

Impregnated Graphite Studies

Another experiment was performed to determine the uranium distribution in a impregnated graphite cyclinder. Four equal-volume samples which were machined from a piece loaded to an average concentration of 46.2 mg U/ml of graphite analyzed 79.4, 44, 33.5, and 28.0 mg/ml, respectively, from the periphery to the core. The average of the four samples was 46.2 mg/ml which is in agreement with the over-all concentration and indicates the uniformity of distribution along the axis.

Three test pieces of graphite, 0.426-inch in diameter and 0.500-inch in length were impregnated simultaneously in a nitrate solution containing 312 mg U/l. An apparent inverse linear relationship between density of graphite and extent of loading was observed when the data were plotted. Thus, the possibility of predicting the extent of loading from the solution concentration and the graphite density exists.

A series of tests was made to determine the effect of pre-oxidation of the graphite on the volume uptake during the impregnation step. By oxidizing at 600 C in air for 50 hours, the external dimensions of a piece were not measurably altered but the apparent density fell from 1.65 grams/cm^3 to 1.47 grams/cm^3. The measured uptake indicated about 85 per cent available pore volume compared to a previous 70 per cent. This technique may be useful if more uniformly impregnated pieces and higher loadings are desirable.

Aluminum-Plutonium Alloy Preparation

Five 100 to 200 gram batches of 1.65 weight per cent plutonium-aluminum were prepared by the reduction of plutonium dioxide with aluminum under cryolite Na_3AlF_6 as a flux. Although analyses have not been made to determine the extent of plutonium losses, the appearances of the metal reguli are indicative of the completeness of reaction.

In each of four runs, the entire charge was placed in the graphite crucible prior to heating and the furnace cycle completed under an argon atmosphere. When a temperature of 1100 C was reached and held for 20 minutes, a very clean metal button was obtained. On the other hand, when a temperature of 1050 C was used with no hold period, the metal was somewhat contaminated and the flux showed evidence of some unreacted plutonium dioxide. No mechanical stirring was used in these experiments although some stirring by convection was apparent, especially in the 200 gram batches. In a single run, the plutonium dioxide was added with the cryolite as an aluminum foil wrapped mixture. In this procedure, the crucible had access to air, and the flux appeared to have a greater oxide content, sticking so tightly that its release could be effected only by breaking the crucible.

A much smaller scale experiment was successfully completed to yield about 22 grams of aluminum - 15 weight per cent plutonium alloy. The button and flux appeared very clean, with very little evidence of unreacted plutonium oxide. This reduction method for preparing aluminum-plutonium alloys proceeds smoothly with no violence and is simple and direct.

Bismuth-Plutonium Dioxide Slurry Studies

An experimental study was started to investigate some of the chemical and physical properties of the system bismuth-plutonium oxide slurry as a "fluid fuel" for the PRP reactor. Several experiments were performed in which bismuth (or bismuth-lead eutectic), uranium dioxide, and magnesium in mole ratios of 7.3:1:0.5 were contacted in cold rolled steel capsules for three hours at 650-700 C. Uranium dioxide is being used as a "stand-in" for plutonium oxide. In each case (except one when the capsule failed), dispersion of the uranium dioxide in the bismuth occurred as determined by microscopic examination and X-ray diffraction analysis. These results are in substantial agreement with findings at KAPL. The dispersion appeared uniform except near the edges, a condition possibly brought about by the capsule material which was wetted, in each experiment, by the slurry. Better dispersion occurred in the bismuth-lead eutectic than in pure bismuth.

Plutonium Oxide Fuels

A series of experiments have been performed on the production of a UO_2-PuO_2 fuel material suitable for use in the PRP reactor. In agreement with the KAPL work, coprecipitation of an ammonium diuranate-plutonium hydroxide precipitate followed by

hydrogen reduction results in mixed crystals provided that the material is heated from room temperature to the 900 C reduction temperature in an atmosphere of hydrogen (actually a nitrogen-1 to 2 per cent hydrogen mixture). When the reduction was preceded by air calcination (900 C), it was not possible to reduce the resultant material to mixed crystals of uranium dioxide and plutonium dioxide. The mixed crystals are desired because of their ease of dissolution for reprocessing.

A total of three reductions were carried out. In the first, the uranium/plutonium ratio was five. Precipitation was with an ammonia-air mixture. The precipitate filtered easily and was washed with ammonium hydroxide solution. It was air dried, then dried overnight at 100 to 120 C, ground to a powder, and reduced in the nitrogen-hydrogen mixture at 900 C for one hour (the sample was introduced into the furnace at room temperature and the furnace brought up to temperature while sweeping with the nitrogen-hydrogen mixture). The resulting powder was brownish-black in color, and X-ray diffraction showed it to be the desired mixed crystal material. An identical sample of precipitate was calcined at 900 C before reduction and did not yield mixed crystals.

A similar preparation was made with a uranium/plutonium ratio of 1.25. The precipitate was not as crystalline as the above, was difficult to filter, and peptized when washed with water but not when washed with ammonium hydroxide. Mixed crystals were not obtained; however, the powder had been calcined prior to reduction. Similarly, denitration at 500 C of a mixture of uranium and plutonium nitrates followed by calcination at 900 C and reduction did not yield mixed crystals. Studies of the rates of dissolution of these various oxides are being made, but results are not yet available.

In another approach, a scouting experiment indicated that uranium dioxide is one of the products of the thermal decomposition of ammonium diuranate in an inert atmosphere. If the diuranate can be decomposed so that the dioxide is the only product, it may be possible to eliminate the use of hydrogen in producing the mixed crystal material. Elimination of hydrogen would be desirable from a safety standpoint.

Crucible Treatment

The possibility of fluorine liberation from graphite crucibles treated with fluorine was investigated and found to be improbable. No fluorine found by mass spectrometer analysis upon heating sample of crucible to 1800 C in vacuum. It is concluded that use of these crucibles in a hydrogen atmosphere furnace is safe from the viewpoint of fluorine corrosion of the heating elements.

6000 PROGRAM - BIOLOGY AND MEDICINE

Geology and Hydrology

Discussions with Dr. Clifford Willis, chief geologist of the Harza Engineering Company, engineer architects for the Grant County P.U.D. for the Priest Rapids and Wanapum Dams, assured us of the desired geological data from the site.

Completion of several geological cross sections in the Wahluke Slope and Pasco Slope areas and correlation of well logs with each other and with the results of field work by others resolved numerous inconsistencies and anomalies and more precisely defined the Pasco Basin to the east. It also permitted the determination

of a detailed Ringold formation stratigraphic sequence. The location of the main course of the Columbia River at each stage of deposition, hence of the nature of the sediments to be expected on the project, is a major result of the correlation; behavior of the ground waters can be more accurately predicted and monitoring wells more reliably and advantageously located.

A new well was drilled to basalt in the 200 West Area near the Z-Plant Area. When the blue clay zone of the Ringold formation was penetrated at a depth of 450 feet it was found that the water bearing sediments below the blue clay were at a significantly higher hydrostatic head than those above. These artesian conditions confirm the belief that the blue clay zone is a good aquaclude and must be extensive areally.

Work was initiated to evaluate the influence of dissolved solids and air in the water used for conducting model studies. It was found that as much as one cc of air per 1000 of water was removed from solution by a tension of 5 feet of water. Tensions of this order are frequently encountered in model studies and much higher tensions probably occur in the unsaturated flow zone beneath waste disposal sites. This released air undoubtedly affects the water transmitting properties of the soil and is particularly important in model studies where reproducible results are required. A design study was initiated to provide equipment to deaerate water for research models.

Geochemical and Geophysical Research

The U.S. Bureau of Reclamation Hydraulic Laboratories and the U.S. Geological Survey Hydrological Laboratory, Denver, Colorado, were visited to obtain information on laboratory soil permeability equipment and methods. As a result, equipment was chosen for a laboratory soil permeability apparatus to permit routine permeability tests on well drilling samples.

Use of shaped charges for well-perforating was discussed in a conference with B. M. Caldwell, president of Jet Research Center, a shaped charge application development company. It was indicated that shaped charges could be applied to the anticipated work here, and that the company, which holds important licensing rights, would cooperate fully. Only a modest investment would be needed for an initial application.

The gamma scintillation spectrometer well probe and associated components were studied to improve field performance. Calculations were made of the anticipated response to uniform cylindrical sources with the probe on the axis. It was determined that a uniform Cs^{137} source 12" in radius will give approximately 90 per cent of the response of the infinite radius source. A calibration source need not exceed about 15" radius if it consists of Cs^{137} deposited uniformly in soil surrounding a section of well-casing, or similar configuration.

The ground water flow direction indicator using conductance probes and gyro-compass orientation indication was made available from Radiation Protection Instrument Research and Development. First testing was unsuccessful because of corrosion in the electrolyte delivery unit of the indicator.

Soil Chemistry

Further research confirmed the unusual soil retention characteristics of Ce(III) previously observed. In the three variable system: per cent retention on soils, pH, and Ce-ion concentration, a region was found where the retention on soils was essentially nil. This region occurs between cerium concentrations of 1×10^{-6} to 2×10^{-6} M and in the pH range 9.5 to 11.5. Since the natural pH of the soil is near this range, it is conceivable that solutions in the critical concentration range could be added to a crib with a very low removal of Ce. The adsorbed Ce can be readily removed by HCl solutions but it is difficult to remove with solutions of salts.

The Gelling of Wastes

Batch equilibrium experiments in water with freshly formed aluminosilicate gel containing Sr^{90} and Cs^{137} indicated that the latter was removed from the gel rather readily by the water leach but that the former was largely retained by the gel. Equilibrium experiments in which dry gel residue was contacted with water and with synthetic aluminum coating waste containing these radioisotopes verified the observation that the aluminosilicate gel had a relatively high affinity for Sr^{90} but a low affinity for Cs^{137}; for example, distribution coefficients for the adsorption by gel from distilled water were >500 and <1, respectively. Although data from the batch experiments with aluminum coating waste were not complete, the same general trend was evident.

The experimental evidence suggested that liquid which is removed from freshly formed gel by compaction and the tension forces of adjacent dry soil probably will contain appreciable concentrations of cesium. If however, the apparent high affinity of soil for cesium in the original waste is also observed for cesium in liquid extracted from the gel, the radioisotope should be removed from solution rather effectively by the soil. Nevertheless, the apparent low affinity of the dried alumonosilicate gel for Cs^{137} would be a distinct disadvantage if the gel were calcined and an attempt made to use the calcined product to "clean up" additional radioactive waste.

Special Studies

The isotherms for the adsorption of ruthenium tetraoxide from carbon tetrachloride solutions by activated alumina were determined at 40 C and 25 C. The higher temperature appeared to favor greater adsorption, however it was planned to determine the isotherm at 15 C to verify this trend.

Studies on the adsorption and desorption of ruthenium tetraoxide vapor by activated alumina indicate a very appreciable hysteresis. This hysteresis effect suggested that a surface reaction had occurred resulting in a greater retention of adsorbed ruthenium tetraoxide molecules than would be predicted from capillary condensation theories. A logical interpretation of the isotherms suggests that several layers of ruthenium tetraoxide were adsorbed by a chemisorption mechanism followed by physical adsorption of the bulk of the tetraoxide molecules. The data have application to any procedure designed to remove or recovery ruthenium by adsorption processes.

Environmental and Radiation Chemistry

A two month's study was completed of the application of gamma spectrometric and beta absorptiometric methods to the analysis of aquatic biology samples independently of chemical separations. The study included 143 samples representing nearly all types of aquatic biology specimens. The results show that as many as 17 radioisotopes may be identified and measured in certain types of samples without chemical separation. These isotopes are: Na^{24}, P^{32}, Sc^{46}, Cr^{51}, Mn^{54}, Mn^{56}, Fe^{59}, Co^{60}, Cu^{64}, Zn^{65}, Zn^{69}, As^{76}, Zr^{95}-Nb^{95}, Cs^{137}, Ba^{140}, La^{140}, and Np^{239}. The precision with which each isotope can be measured in a particular sample depends upon the relative amount present. For the majority of samples in this study, Na^{24}, P^{32}, Sc^{46}, Cr^{51}, Fe^{59}, Co^{60}, Cu^{64}, Zn^{65}, and As^{76} can be measured with a precision of about three per cent. Ba^{140}, La^{140}, and Np^{239} can usually be measured with a precision of ten per cent, while the precision of the Mn^{54}, Zr^{95}-Nb^{95}, and Cs^{137} measurements may be only 25 per cent. Mn^{56} and Zn^{69} determinations were not made on these samples, but could be if the samples are counted immediately after sampling. P^{32} could not be measured in the muscle tissue of any fish without chemical separation, and some degree of chemical separation would be required to improve the precision of measurement of the other isotopes. The small aquatic organisms such as algae, plankton, insects, and insect larvae contained a wide spectrum of the short-lived radioisotopes and relatively small amounts of longer-lived isotopes which were measured after some decay. Fish, except for the juveniles, contained mainly the long-lived isotopes, P^{32}, Zn^{65}, and Cs^{137}. The ratio of P^{32} and Zn^{65} in small organisms was about 10:1. In suckers, squawfish, sculpins, whitefish, and carp, the ratio varied from 1:1 to 1:10.

Gamma-gamma coincidence counting of the 1.17 and 1.33 Mev gamma rays can be used to determine Co^{60} in reactor effluent water without chemical separation. Because of the very small amount present, the residue from a one liter sample must be counted for an hour after a delay of one week (to allow the Na^{24} to decay) to obtain the accuracy required.

Fe^{59} and Ga^{72} radiochemical analyses on reactor effluent water were made over a period of several weeks with the separated isotopes placed on an automatic sample changer for beta decay curve determination. In the cases of both isotopes some of the decay curves showed the presence of an impurity of from one to four days half-life. Further studies are under way to identify and remove the interference from this isotope or isotopes.

The over-all concentration of gamma emitting radioisotopes on vegetation in the plant environs has doubled since December, 1956. In addition to the cerium, iodine, ruthenium, zirconium, and niobium isotopes previously measured, Ba^{140}-La^{140} is now present in measurable quantities. The relative amounts of these isotopes suggest that they are debris from atomic weapons tests. Measurements on off-site samples will be made to verify this conclusion.

Dosimetry

A comparison was made of the chemical protection afforded aqueous erioglaucine solutions by urea and thiourea. The protective capacities differ by a factor of one thousand despite the similarity in structure. The protective action measured as the ratio of the rate of the radical-protector reaction to the rate of the radical-dye reaction was found to be linearly related to the concentration for both urea and thiourea over a 50-fold change in concentration.

Experimental determinations were repeated of the fraction of energy emitted by a spherical, homogeneous, aqueous solution source of P^{32} which is absorbed in the source itself. Two lucite-walled cavities, 2.222 cm diameter, were used and the absorbed dose was measured by means of the ferrous sulfate dosimeter after known periods of time. In each case 90-93 per cent of the energy liberated was absorbed by the source itself. A slight but steady decrease in energy absorbed at longer times was noted. This might be due to impurities in the P^{32}, high background radiation, or some chemical effect on the dosimeter. These factors will be investigated, and the experimentally determined absorbed dose values will be compared with values obtained using the various theoretical equations proposed for this calculation.

Nine off-site samples of underground water were analyzed for natural tritium content.

CUSTOMER WORK

Iodine-131 Analysis

Analysis of vegetation I-131 by chemical leaching-beta counting was found to be related significantly to the time lapse between deposition of I-131 on the vegetation and actual removal by leaching. Iodine was added by spiking with tracer solution, admittedly different from deposition of plant releases. Iodine-131 recovery any time after the day of deposition was about a factor of three low--the factor used for several weeks to increase I-131 observed by leaching-beta counting.

Day Analyzed	0	1	2	3	4	5	7
% I-131 Recovered	78	36	31	28	27	30	25

To measure vegetation I-131 more accurately a four-channel gamma counter is being assembled and tested. As soon as the instrument functions, Regional Monitoring anticipates reducing their requirements for I-131 analyses tenfold. One person within the Analytical Laboratories can be reassigned.

The work of one-fourth of a measurements clerk will be eliminated by a completed program for machine calculation of activity densities of radioisotopes in the river at Pasco. The Pasco densities are based upon measurements of radioisotopes in reactor effluent cooling water.

Redwing Program

The Redwing analytical program is 90 per cent complete on the basis of received and scheduled samples. Marine "life" received has included one octopus fragment and several sea snakes. The best monitor of bomb debris radioisotopes seems to be the clam. Recently Mn-54 was identified and is being measured for 44 selected specimens.

V. R. Cooper

Manager
Chemical Research & Development

VR Cooper:bp

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data
Brandon Gunyou	4/15-16/	Koppers Company Pittsburgh, Penn.	Discuss experiences in operation and direct maintenance at the Hot Semiworks and in-line instrument development.	RJ Sloat	Yes
L. J. Barron	4/10/	Pigments Department duPont Company Wilmington, Del.	Applications of titanium to processing equipment.	OF Hill AE Smith	Yes

VISITS TO OTHER INSTALLATIONS

J. R. Raymond	4/1-2/	US Geological Survey Hydrologic Laboratory Denver, Colorado	Examine hydrological lab equipment for possible application at HAPO	AI Johnson	No
D. W. Pearce	4/4/	Washington State College Pullman, Washington	Present paper at 8th Annual Conference on Waste Disposal		No
D. W. Rhodes	4/5/	Phillips Petroleum Co. Idaho Falls, Idaho	Discuss possible work in waste disposal at the NRTS	CE Stevenson CM Slansky WH McVey	No
R. E. Burns	4/1-5/	Iowa State College Ames, Iowa	Recruiting trip		No
G. J. Alkire	4/8/	Savannah River Plant Augusta, Georgia	Discuss problems associated with instrument development activities.	CH Ice	Yes
	4/9-11/	National ACS Meeting Miami, Florida	Attend Meeting and present technical paper		No

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data
R. F. Maness	4/9-11/	Corrosion Short Course Spokane, Washington	Attend Corrosion Short Course		No
R. L. Moore	4/7-12/	National ACS Meeting Miami, Florida	Present a paper and recruit technical personnel at Miami.		No
	4/15-16/	duPont Company Savannah River, Ga.	Inspect hot cell equipment and confer on process chemistry at duPont and ORNL	DG Karraker	Yes
	4/17/	Oak Ridge National Lab. Oak Ridge, Tennessee	Inspect hot cell equipment and confer on process chemistry at duPont and ORNL	FL Culler	Yes
V. R. Cooper	4/8-12/	National ACS Meeting Miami, Florida	Chairman of Committee		No
	4/9/	AEC Washington Office Washington, D.C.	Meeting on chemical reprocessing of power reactor fuel elements	WN Munster	Yes
	4/15/	ORNL Oak Ridge, Tennessee	Discuss new developments on separations processes and equipment.	FL Culler	Yes
	4/16-17/	Argonne National Lab. Lemont, Illinois	Discussion on separations technology, waste products disposal.	S. Lawroski	Yes

BIOLOGY OPERATION MONTHLY REPORT - APRIL 1957

A. Organization and Personnel

Dr. Robert L. Uhler joined the Plant Nutrition and Microbiology Operation on April 19.

B. TECHNICAL ACTIVITIES

FISSIONABLE MATERIALS - 2000 PROGRAM

BIOLOGICAL MONITORING

Samples of terrestrial and aquatic organisms are routinely collected and assayed for radioactive contaminants released to the atmosphere, impoundments, and the Columbia River.

Atmospheric Contamination

Concentrations of I^{131} in the thyroid glands of rabbits are tabulated below, in decreasing order:

Collection Site	$\mu c\ I^{131}/g$ thyroid Average	$\mu c\ I^{131}/g$ thyroid Maximum	Trend Factor
East of 200 East Area	4×10^{-3}	1×10^{-2}	-
One mile S. of Redox	4×10^{-3}	6×10^{-3}	-
West of 200 West Area	2×10^{-3}	4×10^{-3}	-
Four miles SW of Redox	2×10^{-3}	4×10^{-3}	+ 3
Meteorology Tower	1×10^{-3}	3×10^{-3}	- 5
Prosser Barricade	8×10^{-4}	1×10^{-3}	-
100-B Area	7×10^{-4}	1×10^{-3}	-
Route 2S, mile 3	2×10^{-3}	2×10^{-3}	- *
Wahluke Slope, ENE	2×10^{-3}	2×10^{-3}	+ 2*
Wahluke Slope, N.	1×10^{-3}	2×10^{-3}	+ 2*
Five miles SE of Redox	9×10^{-4}	2×10^{-3}	- 6*

* The last four trend factors compare values with samples obtained in February rather than March, because collections are made bi-monthly.

These values are approximately one-half those of 1956 at central collection sites and approximately twice last year's values at project perimeter locations.

Fallout debris, presumably of off-Plant origin, was present in rabbit tissues and feces in the following concentrations:

Sample Type	μc FP's/g sample Average	Trend Factor
Bone	4×10^{-5}	-2
Liver	6×10^{-6}	-
Feces	2×10^{-5}	-

Swamp Contamination

The following concentrations of fission products were found in tissues of waterfowl at the 221-U swamp:

Sample Type	μc FP's/g tissue Average	Maximum	Trend Factor
Coots			
Bone	5×10^{-4}	8×10^{-4}	-
Soft tissues	1×10^{-4}	2×10^{-4}	- 10
River ducks			
Bone	3×10^{-3}	4×10^{-3}	-
Soft tissues	2×10^{-4}	4×10^{-4}	- 2

These values are approximately the same as those of one year ago.

Columbia River Contamination

The contamination levels for beta emitters in representative aquatic forms and in waterfowl for April are shown in the following table. With the exception of plankton, virtually all of the activity reported is from P^{32}.

Sample Type	Collection Site	μc beta emitters/g tissue Average	Maximum	Trend Factor
Plankton	Hanford	2×10^{-2}	3×10^{-2}	- 5
Caddis larvae	"	3×10^{-3}	6×10^{-3}	-
Minnows	"	6×10^{-4}	9×10^{-4}	-
Whitefish *	"	8×10^{-5}	3×10^{-4}	- 5
Shorebirds *	"	2×10^{-3}	5×10^{-3}	-
Swallows *	"	8×10^{-4}	2×10^{-3}	-
Diving ducks *	"	5×10^{-4}	3×10^{-3}	- 6
River ducks*	"	3×10^{-4}	4×10^{-3}	-20
Gulls*	"	6×10^{-5}	3×10^{-4}	-
Mergansers *	"	3×10^{-5}	4×10^{-5}	- 2

* Values are for flesh. Concentrations in bone are about ten times higher for fish and approximately equal for waterfowl.

Decreasing trend factors are presumably due to a greater number of migrants diluting the sample. Current values are two to five times those observed during April 1956.

[redacted]

Samples of 25 goose eggs collected during the current nesting survey contained P^{32} concentrations identical to last year's values, and were as follows:

Egg Component	P^{32} concentration in μc/g
Shell	1×10^{-4}
Yolk	1×10^{-4}
Albumen	1×10^{-5}

The contamination level in river organisms was little different from last month. The fivefold decrease in the concentration of beta emitters in plankton probably resulted from the shutdown of the 100-F reactor and increased flow of the river. The apparent decrease for whitefish is probably not real but results from sparse samples (fishing was poor) and considerable variability between individual fish. The activity density of minnows, considered the most reliable index of contamination in river organisms, was about 1.5-fold greater than one year ago.

Effects of Reactor Effluent on Aquatic Organisms

Routine monitoring of effluent was not carried out this month because of the shutdown of the 100-F reactor and control water supply difficulties at 100-K.

A test was started with juvenile chinook salmon to determine the relative toxicity of Cr(III) vs Cr(VI). No effects are yet evident. Significant mortality occurred among mayfly nymphs held in 0.32 ppm Cr(VI) for two weeks. These forms are more sensitive to the chromium than other invertebrate organisms which have been tested.

During the month the rate of mortality of juvenile whitefish held in temperatures 2 C and 3 C above average for the Columbia River was about the same as that of the controls. Cumulative mortality over a period of five months has been greatest in the highest temperature, however.

River organisms were exposed for eight hours to effluent collected from a reactor tube which contained a ruptured fuel element. The concentration of radioactive materials in this test is believed to have exceeded that which would occur in the Columbia River following a rupture. As a result of this "cloud" of rupture debris, the activity density of algae growing on rocks was increased about 2.5 fold, but there was little or no increase in the activity density of small fish. The majority of the radioactivity associated with the rupture debris appeared to originate from rare earths and Sr^{89-90} although appreciable amounts of Ba^{140}-La^{140}, Cs^{137}, and Ru^{106} were also present. In the sample tested, 80 per cent or more of the radioactive materials present was associated with particles which settled in less than 24 hours.

BIOLOGY AND MEDICINE - 6000 PROGRAM

METABOLISM AND TOXICITY OF RADIOACTIVE MATERIALS

Plutonium

Experiments were completed comparing the therapeutic effectiveness of zirconium citrate alone, zirconium citrate mixed with calcium gluconate, and zirconium citrate followed immediately by a separate injection of calcium gluconate. Therapeutic agents were administered intraperitoneally one hour following intravenous administration of Pu IV citrate. There was no significant difference in the therapeutic effectiveness of any of these treatments as evidenced by 48-hour excretion and bone deposition data. The zirconium citrate was much better tolerated by the animals when mixed with calcium gluconate.

Cesium

Rats were sacrificed after 300 days chronic feeding of Cs^{137}. Groups remain to be sacrificed after 400 and 500 days. Analysis of data obtained through 200 days chronic feeding indicate a Cs^{137} deposition about 10 to 20 per cent higher than would have been predicted from single administration results.

Zinc

Rats sacrificed one hour after intravenous injection of Zn^{65} show the highest zinc concentration in liver, pancreas, and kidney. About one-third of the injected dose was present in the liver. About 8 per cent of the dose was present in total bone and about 16 per cent was found in the gastrointestinal tract.

Iodine

There is only a suggestion of a slight reduction in the thyroid avidity for I^{131} in the group of swine fed 45 μc/day for 25 weeks. The estimated thyroid dose is between 7,000 and 10,000 rads.

Two six-year-old ewes in the group born to and weaned from ewes fed 5 μc of I^{131}/day and then placed on a regimen of 5 μc/day expired. At least one of the ewes showed tumor involvement of the thyroid gland similar to that observed in a comparable group last year.

Strontium

A short-term study was initiated to determine if Sr^{89} in milk from a ewe fed Sr^{89} would be absorbed by rats to the same extent as Sr^{89} added directly to ewe's milk. (Rat femurs will be assayed at seven and thirty days.) About 10 per cent of Sr^{89} added to ewe's milk was associated with the casein fraction. The pH of raw milk from both ewes and cows was 6.8.

[redacted]

Radioactive Particles

Ten days after intratracheal injection of 0.041 μg/g $Pu^{239}O_2$ in two dogs, 40 per cent of the administered dose was retained in the lungs, 44 per cent was accumulated in feces and less than 0.3 per cent in the urine. Other organs in descending order of plutonium content at time of necropsy were: pulmonary lymph nodes, trachea, and ovary. No obvious relationship could be seen between lung burden and the blood-urine ratio.

Gross examination of 33 mouse lungs, approximately 400 days after intratracheal injection of 0.06 μc Pu^{239}, revealed an average of 1.39 papillary cystadenomata per mouse and 61 per cent with a non-determinate fibrosis. Microscopic examination of 17 of these lungs showed an average of 1.23 papillary cystadenomata per mouse and 65 per cent with the non-determinate fibrosis. Two lungs or 12 per cent of those subjected to histological examination showed a malignant squamous cell carcinoma. Eleven of the 33 mice were analyzed for Pu^{239}. About 12 per cent of the original dose was retained in these animals, approximately 40 per cent in the lung, 20 per cent in the liver, and 10 per cent in the spleen. The remaining 30 per cent was presumably largely deposited in the bone.

Ninety-five per cent of the retained radioruthenium was in the lungs, 12 weeks after intratracheal injection of 0.038 μc $Ru^{106}O_2$ in mice. The remainder was present largely in the tissues usually involved in lung clearance mechanisms: G.I. tract, trachea, lymphatic tissue, and other tissues of the reticulo-endothelial system.

Gastrointestinal Radiation Injury

The intestines of rats that had received intravenous injections of Fe^{59} were surgically exteriorized and exposed to 1500 r of X-radiation. Daily fecal collections showed that intestinal hemorrhage occurred in the exposed rats principally on the sixth day following irradiation. This finding is in agreement with earlier results obtained after irradiation of the *in situ* intestine and shows that the hemorrhage is a direct effect of damage to the intestine.

Relative Biological Effectiveness

In an attempt to eliminate the source of variation in the iron dosimeter results, the P^{32} and S^{35} solutions obtained from Oak Ridge were muffled to remove any organic material. This did not improve the results. Spectrographic data received from Oak Ridge indicates that there is an appreciable iron content in these two isotope solutions. Presence of this iron could easily account for the variations observed in the past. The Chemical Research Operation has been contacted for assistance in further purifying these solutions.

Extremely small flakes of platinum metal were prepared as substrates for the deposition of Po^{210}. It appears that these platinum flakes may be used as carriers for the polonium during irradiation of yeast cultures and that the polonium may thus be maintained nearly uniformly distributed in the culture.

Turbidity from the microorganisms can be evaluated by allowing the platinum flakes to settle out of the suspension. The flakes are currently being sized to obtain a fraction which will be readily suspended but settle out within less than a half a minute of standing. It is estimated that no more than a million platinum particles will be required to provide uniform radiation in a five milliliter culture.

Supplementing the minimal medium used for growing yeasts with 0.2 per cent peptone and 0.1 per cent yeast extract decreased the effectiveness of tritium by about 30 per cent, using 90 per cent reduction of viability as the criterion of damage. The influence of temperature was retested and the earlier finding that viability is less reduced at 30 degrees than at 20 degrees was confirmed.

Genetic Effects of Metabolized Isotopes

Haploid yeast cells grown for transmutation studies have been tested after two weeks storage in a dry form. There is a possible indication of higher mutation rate in cells which previously metabolized S^{35} as compared with cells subjected to the same amount of radiation from S^{35} outside the cell. The differences are as yet too small to be significant. Cultures are being held and will be opened after a longer exposure period.

Uptake of Radioactive Substances by Growing Plants

Barley was grown by the Neubauer technique using organic resins as carriers for essential cations and anions. The amount of calcium was the same in all cultures but the amount of strontium was varied. Analysis of leaf tissue showed that there was no effect of the strontium on uptake of calcium. The concentration of Sr^{89} in the leaves increased more rapidly with increasing amounts of strontium in the substrate than anticipated from an assumption of direct proportionality.

HA Kornberg
Manager
BIOLOGY OPERATION

HA Kornberg:RC Thompson:es

C. Offsite Visits and HLO Visitors

Name	Dates of Visits	Company or Organization Represented & Address	Reason for Visit	H.W. Personnel Contacted	Access to Restricted Data	Areas and Buildings Visited
		VISITS TO HANFORD WORKS				
Drs. M.E. Ensminger and Fowler	4/18/57	Department of Animal Husbandry, WSC, Pullman	Consult with Animal Farm personnel.	L.K. Bustad H.A. Kornberg	No	100-F: 141-M, 108
Dr. W.W. Grigorieff	4/25/57	AEC Fellowship Program, ORINS	Discuss fellowship program and visit facilities.	D.E. Warner HA Kornberg RF Foster LK Bustad	No	100-F: 108, 141-M, 146
Dr. Frank Hoecker	4/25/57	Head, Biophysics Dept. U. of Kansas	Discuss fellowship program.	"	No	"
		VISITS TO OTHER INSTALLATIONS				
P. A. Olson	4/2-4/6	Richardson Springs, Calif.	Attend annual Pacific Fishery Biol. Meeting	-	No	-
R. F. Foster	4/3	Wenatchee, Wash.	Present paper to Kiwanis Club	-	No	-
W. J. Clarke	4/7-10	Pullman, Washington	Confer with consultant at WSC and present a paper at NW Veterinary Conference, AMVA	Ensminger	No	-
M. F. Sullivan	4/15-19	Chicago, Ill.	Consult on radiation of tissue respiration with DuBois at U. of Chicago and present a paper at Fed. Mtgs.	DuBois	No	-
H. A. Kornberg	4/26-5/1	UCLA, AEC Project, Los Angeles, Calif.	Attend AEC Bio-Medical Program Directors Mtg.	R.J. Buettner T.J. Haley	Yes	-

D. Lectures

a. Papers presented at meetings

R. F. Foster, April 3, 1957 - "Effect of Atomic Energy on the Peoples of the World," Kiwanis Club, Wenatchee, Washington.

W. J. Clarke, April 9, 1957 - "Application of Radioactive Isotopes in Agriculture," Annual Conference for Veterinarians at the State College of Washington, Pullman, Washington.

M. F. Sullivan, April 16, 1957 - "Effects of Gastrointestinal Tract Irradiation on Iron Uptake and Excretion by Rats," Society for Experimental Biology and Medicine, Federation Meetings, Chicago, Illinois.

b. Seminars

April 2, 1957 - M. F. Sullivan, "Gastrointestinal Tract Irradiation on Fe^{59} Uptake by Rats"

April 2, 1957 - J. L. Terry (Maj., USAF), "Dosimetry Calculations for Aquatic Organisms"

E. Publications

1. Gorbman, A., Allyn Waterman, C.M. Barnes, and L.K. Bustad, "Thyroidal Function in Fetal and Pregnant Sheep Given Low-Level Dosages of I^{131}," Endocrinol. 60 (4), 565-566, (1957).

2. Bustad, L.K., L.A. George, Jr., S. Marks, D.E. Warner, C.M. Barnes, K.E. Herde, and H.A. Kornberg, "Biological Effects of I^{131} Continuously Administered to Sheep," Radiation Research 6, 380, March 1957.

3. Bustad, L.K., S. Marks, L.A. George, Jr., and L.J. Seigneur, "Thyroid Adenomas in Sheep Administered I^{131} Daily," Nature 179, 677, March 30, 1957.

OPERATIONS RESEARCH AND SYNTHESIS OPERATION MONTHLY REPORT

April, 1957

ORGANIZATION AND PERSONNEL

P. E. Leaverton was promoted from Technical Graduate to Statistician effective April 1.

OPERATIONS RESEARCH ACTIVITIES

Economic Studies

Work in the economic area continues to be limited due to concentration of effort on Operation Pool.

Work on the study of HAPO motivations in line with AEC objectives is essentially complete. Considerable insight has been gained into the formulation of appropriate measurement criteria and this increased understanding and the conclusions reached are being compiled into a formal report.

Personnel Data

Activities on this program during the month centered around the preparation of a progress report entitled, "Personnel Study - Matching of Individuals with Opportunities." The report describes a system that may be useful in dealing with the problem of matching the qualifications of an individual with plant-wide opportunities available. A meeting was held with Employee Relations managers to communicate the results of the study to date, and describe details of a test to check the practicality of the system. This test is presently being made. The direction of future endeavor will depend to a great extent on the results of the test, which is scheduled to be completed about May 15.

Investigation of Problem Areas

An interim report dealing with the philosophy of measurements in general, and describing an approach to a measurement program applicable to the Hanford Laboratories Operation has been prepared. This study has led to particular consideration of the problem of defining and expediting the flow of feedback information relating to component objectives. The present study of personnel data is being oriented in this direction, and the possibility of mathematical assistance in the area of financial data processing is again being considered. It is expected that by the end of May a specific program or programs in this area will be formulated.

Further discussions were held with Radiation Protection personnel concerning the regional monitoring study.

STATISTICAL AND MATHEMATICAL ACTIVITIES IN SUPPORT OF RESEARCH PROGRAMS

2000 Program - Metallurgy

A statistical analysis was made of data from a study to determine the percent uranium content of five Savannah River test slugs. Components of variance procedures were utilized to partition the total experimental error into sampling plus dilution error and titration error. Estimates were also constructed of the bias present in standards used to check titration techniques. The results of the analysis will be reported to interested personnel in the General Chemical Analysis Operation.

Further talks were held with personnel of the Coating and Corrosion Operation concerning the variable pH factor frequently encountered in corrosion experiments. It was concluded that efficient use of hot pH data demands increased knowledge of the relationships between pH and solution temperature.

2000 Program - Reactor

A new method of constructing confidence interval estimates of K_{∞}, the coefficient of fast neutron multiplication, was derived for personnel of the Reactor Lattice Physics Operation. The method, based on simultaneous confidence region estimation of both parameters in a linear function relating two cadmium ratios, is a marked improvement over all previously suggested procedures in a sense of generating an interval of much shorter expected length. A statement of the method, including a brief geometrical description of its construction, was submitted to interested persons (Unclassified letter to D. J. Donahue, "Exact Confidence Intervals for K_{∞} Estimation Based on the 'D' Method," dated April 10, 1957).

Certain properties of solutions of an integral equation which arises in connection with stability studies for nuclear reactors were discussed with a member of the Nuclear Physics Research Operation

6000 Program - Biology and Medicine

Analysis continued in April of the fixed vs. variable dose experiment described in the February report. Sample-dilute-count data analysis was concluded, and a report to interested personnel in the Plant Nutrition and Microbiology Operation is being prepared.

Results of a recent pilot study of possible Ru deposition antidotes for rats were used to design a more detailed experimental investigation of the more promising treatment combinations. The suggested design was reported to the Metabolism Operation (Unclassified letter to B. Kawin, "Experimental Design - Radiation Antidote Study," dated April 12, 1957).

A regression study was made on new data from an experiment concerned with the retention of $Ru^{106}O_2$ deposited in the lungs of mice. A new turnover curve and a half-life function were calculated, along with appropriate confidence interval estimates. The results were reported to interested personnel in the Pharmacology Operation (Unclassified letter to L. A. Temple, "Intratracheal Hydrosol Turnover Curve," dated April 11, 1957).

[redacted]

STATISTICAL AND MATHEMATICAL ACTIVITIES FOR THE PRODUCT DEPARTMENTS

Fuels Preparation Department

Work is continuing on the development of a system of reporting various quality characteristics of fuel elements. The system under consideration is intended to give higher levels of management an objective picture of the overall quality of processed fuel elements periodically, and also to furnish operators and immediate supervision with action-type control charts based on shorter time intervals.

Preparations are presently being made, in conjunction with process engineers, to conduct a process capability study of the various phases of fuel element processing. This study is being made to assist in the setting of more realistic specifications, to evaluate vendor performance, and to point out areas in which effective measures might be taken to reduce process variation.

Excessive rejection of recovered slugs at the pickle inspection station has sometimes resulted in an insufficient number of acceptable pickled slugs to keep all canning lines busy. A method was developed, in conjunction with Quality Control personnel, in which lots of recovered slugs would be sampled in an effort to prevent sending through the pickle process lots containing an excessive number of rejects. A sampling plan for this purpose was devised.

Assistance in setting up an experiment to evaluate testing equipment designed to detect the presence of foreign matter in the core of canned I and E slugs was given to testing personnel.

Assistance was given in designing an experiment to detect any difference in bond rejects due to the use of virgin or scrap alsi.

The voltage setting that would reject 95% of all canned slugs with residual can wall thickness of 20 mils or less was computed for the penetration testing equipment.

Assistance was given radiation monitoring personnel in interpreting data which were collected to determine the dosage rates of personnel handling canned slugs.

A study is being made to determine any difference in residual can wall thickness between slugs processed by different canning lines.

Considerable data concerning the various yield characteristics of slugs have been gathered. They will be analyzed first to determine if significant differences exist due to different vendors, rod numbers, and slug numbers. The data have been keypunched and the problem has been programmed in preparation for this analysis.

A graph was prepared which compared K lot vs. M lot metal with respect to rupture rates at higher power levels. Confidence limits were calculated for each point in the curve in order to indicate the uncertainty which should be associated with the overall fit of rupture rate vs. exposure. The same data were used in a similar study discussed later in this report.

Two problems concerned with sample sizes were considered. One related to the number of slugs for which the length should be measured in order to determine the effect of relaxing specifications on cap heights. The other was concerned with sampling cans for visual inspection.

The advisability of using the distribution of individual results rather than that of average values as a basis for an acceptance sampling technique was considered.

A quarterly report was issued summarizing the statistical work performed for the Fuels Preparation Department between January and March, 1957 (HW-49733, "Statistical Services for Fuels Preparation Department - 3rd Quarter - FY 1957," 4-19-57).

Irradiation Processing Department

In the analysis of rupture experience, the data consists of the exposure at rupture of the tubes with ruptured fuel elements, plus the exposure at discharge (or the exposure at the time of the data collection) for the remaining tubes. A method for estimating rupture rates at different exposures from such data was recommended (HW-49661, "Suggested Method for Estimating Rupture Rates," 4-15-57).

In connection with the use of recent rupture experience to adjust reactor powers for "optimum" performance, a rough draft report was submitted to the Process Technology Operation in which suggestions for evaluating various alternative actions on the basis of statistical risk were given. Copies of this are being studied in anticipation of a future meeting of personnel interested in this problem.

The considerable amount of rupture data pertaining to K and M lots have been analyzed, primarily in order to compare these two types of metal. The comparisons were made for different power categories. Confidence intervals around the best estimate of the ratio of rupture rates at a given exposure were calculated (HW-49515 RD to R. R. Bloomstrand, "K Lots vs. M Lots with Respect to Rupture Rates," 4-3-57).

Exposures at rupture from multiple failure lots were compared with corresponding data from single failure lots. This comparison is important in view of the large contribution to the total frequency of ruptures by a few multiple failure lots. It is hoped that a rather firm plan can be developed in which certain lots will be discharged if their rupture experience at low exposure indicates they are probably multiple failure lots. Work is continuing in this general area.

Data from PT-76-MT were analyzed to determine the effect of non-uniform distribution of voids in the braze layer on slug warping during irradiation. A design was used in which control and test slugs were alternated within each tube, resulting in a paired comparison analysis.

All the data from PT-105-611-A have now been submitted. This production test deals with the effects of reactor variables on dimensional changes. Necessary calculations for the analysis are now being made.

[redacted]

Considerable attention is now being given the problem of establishing an operating bulk outlet temperature for a given reactor such that the probability of exceeding a specified limiting temperature is remote. Sources which would cause this event are errors in temperature measurements, temperature increases due to BPA power failures, temperature increases due to loss of one or more pumps, and increases due to power surges. Expected frequencies were calculated for hypothetical cases differing with respect to the magnitude of the temperature increases due to the above causes.

An operating characteristic curve was constructed for the double sampling plan which is now being used as a basis for accepting lots of reactor tubes.

Statistical significance test procedures applicable to the current work sampling study in the K areas were set up for interested personnel in the Industrial Engineering Operation. Information on types of errors, operating characteristic values, and consequences of particular errors was also provided (Unclassified letter to E. C. Arbuckle, "Test Procedures for Work Sampling Data," 4-22-57).

A quarterly report was issued summarizing the statistical work performed for the Irradiation Processing Department between January and March, 1957 (HW-49731, "Statistical Services for Irradiation Processing Department - 3rd Quarter - FY 1957," 4-19-57).

Chemical Processing Department

The study concerned with measurements of depleted uranium in the Purex and Redox streams is continuing. Estimates of density variance, between and within operator variance on manometer readings, and specific gravity variance have been made for individual batches. These results will be combined into a monthly variance estimate for total depleted uranium for the system. Simplified methods of computing monthly variances will also be recommended.

Facilities Engineering personnel were concerned with sampling different types of one-shot jobs, both in radiation and non-radiation zones, for "effectiveness." A given job would be classified as being either effective or non-effective by observation. Required sample sizes were computed as requested.

A quarterly report was issued summarizing the statistical work performed for the Chemical Processing Department between January and March, 1957 (HW-49738, "Statistical Services for Chemical Processing Department - 3rd Quarter - FY 1957," 4-19-57).

OTHER STATISTICAL AND MATHEMATICAL ACTIVITIES

Activities for Other Operations

As requested by SS measurements personnel, the method currently in use for calculating U-235 consumed in a reactor during a given time period was investigated. Due to the bias in the present method, suggested changes in this procedure were made. Work is proceeding on the evaluation of various accountability check points to determine accountability capabilities at each place.

Activities within Hanford Laboratories Operation

Discussions were held with interested personnel of the Reactor Lattice Physics Operation concerning the underlying mathematical and probabilistic assumptions that must be satisfied for rigorous application of least square estimation techniques. A short course on the Gauss-Markoff theorem was conducted.

Work continued for the Radiation Protection Operation on the statistical evaluation of the current method of calibrating health badge film density readings. A study of January and February beta calibration data indicated that film lot and calibration exposure data provide relevant information that should be utilized.

The Radiation Protection Operation requested a statistical analysis of human Pu excretion data to determine the existence or non-existence of a unique underlying functional relationship between excretion rate and time that would have general predictive value for such cases. Results of the analysis, including estimated excretion functions for individuals were submitted to interested persons (Unclassified letter to J. W. Healy, "Regression Study - Pu Excretion," dated April 23, 1957).

The general procedures and techniques for computing trend lines for percentiles were supplied to the Employee Relations Operation. These include simple, weighted, least squares regression methods, and will be sent to interested persons who occasionally need such techniques to summarize salary data.

Statistical guidance was provided to the Regional Monitoring Operation in determining optimum procedures for sampling and analyzing area vegetation for contamination. Discussions have since been held with interested persons of the Radiation Protection Operation and the Chemical Research Operation to establish reasonable means of assaying the relative efficiency of the various procedures.

Final calculations are being made in preparation for the issuance of a report on the reactor effluents study concerned with relating isotopic concentrations to reactor variables.

Statistical and Mathematical Research and Development

A formal report is being prepared on the statistics of estimating the ratio of two counting rates. Material included will cover point estimation and confidence interval estimation based on the normal approximation and the propagation of error formula for high counting rates, and exact procedures based on small sample theory for low counting rates.

Recursion formulas were derived for certain occupancy probabilities related to the multinomial distribution. An IBM 650 routine using the formulas is being written and tables will be computed. Many small sample non-parametric independence and randomness tests, as well as equality of counting rate tests, use this occupancy distribution to generate critical points.

A statistical and mathematical investigation was initiated in April into the general problem of setting tolerance limits on an industrial product in the presence of appreciable measurement error.

In the use of one-sided tolerance limits the usual development assumes an infinite population. However, for finite populations the limits obtained assuming an infinite population are conservative. In the development of appropriate factors for the finite case, it is necessary to know the variance of the standard deviation for the different cases which may occur. An empirical approach using repeated sampling from certain specified finite populations has been programmed for the electronic computer, and will give an approximate determination of the frequency distribution and the variance of the standard deviation for certain combinations of population and sample size.

OFFSITE VISITS AND VISITORS

P. M. Thompson visited the Operations Research and Synthesis Consulting Service in New York on April 1, and attended the Harvard International Symposium on Switching Theory April 2 through April 5.

Carl A. Bennett, Manager
OPERATIONS RESEARCH & SYNTHESIS

CAB:jbk

RADIATION PROTECTION OPERATION MONTHLY REPORT - APRIL, 1957

A. ORGANIZATION AND PERSONNEL

Organization

No significant changes in organization occurred.

Force Summary	3-31-57	4-30-57
Exempt	41	41
Nonexempt	201	198
Total	242	239

B. ACTIVITIES

Radiation Monitoring

During a routine personal survey by Radiation Monitoring personnel at the exit of a radiation zone, minor contamination was found on the shoes of the same construction employee for two consecutive days. Further checks indicated contamination on the employee's socks and trousers. An investigation by the Radiation Monitoring supervisor revealed that the employee had been employed at three other AEC sites, prior to his coming to Hanford, and that this was the second instance of his employment on construction projects here. Savannah River, Oak Ridge and Fernald were the other AEC sites at which prior employment had been obtained. A thorough survey of the employee's home revealed no detectable contamination. Bioassay results of the individual were negative.

Particulate contamination was spread from the 107-C west basin when the basin which was out-of-service was allowed to dry. Particles averaged 3 to 8 per thousand square feet over an area of about 12 square miles south of the basin.

In the Plutonium Metallurgy Operation an employee, who failed to survey completely his surgical gloves when he removed them from hood gloves, detected contamination on both hands during a four-fold check. His hands were cleaned to less than 500 d/m. A complete survey of the employee, including nasal smears, indicated no further contamination. The follow-up survey of the employee's locker revealed contamination on gloves to greater than 40,000 d/m and 2,000 d/m on a pair of coveralls. Contamination was also found on the floor, gloves and knobs in rooms 47-A and B.

In the Radiometallurgical laboratory, monitoring was provided for the removal of an irradiated slug can from the basin and subsequent positioning on a platform for transit measurements and photographing. A maximum radiation measurement of 5 r per hour at 2 inches was obtained with body dosage rates not exceeding 500 mr per hour. A 1280 curie cobalt-60 cource was placed in B cell and an r meter was used for a determination of the radiation level. A radiation intensity of 17,760 r per hour was noted at 1 foot from the source. This reading is in the right order of magnitude assuming the accepted figure of 1.35 r/hour/curie of Co^{60} at 1 meter. Body dosage rates for this determination did not exceed 600 mr/hour.

In the Biology laboratory, the experiment with the steer, as reported last month, continued with a final injection of 4 mc of zinc-65. The total amount of zinc-65 administered to the animal was approximately 26 mc. The maximum hand dose rate during the final injection was 9 r/hour. The autopsy was performed in the biology burial trench with a maximum hand dose rate of 500 mr/hour.

Approval was received on the final draft of the 300 Area Evacuation Plan on which the Radiation Protection Operation has been collaberating with others in HLO and FPD.

A detailed report of Radiation Monitoring is contained in document HW-49854.

Regional Monitoring

Analyses of water samples from two Redox wells indicated the first Sr^{90} ever to be detected in ground water at HAPO. This is primarily of historical interest and constitutes no significant radiological hazard.

The average daily emission of I^{131} remained the same as March -- 1.1 curies. Essentially, all of the I^{131} released was from the Purex plant.

The fallout of nuclear debris continued throughout the month. The source of this material was probably from foreign bomb tests as reported in the newspapers.

The Analytical Chemistry group reported that the gray wedge analyzer, which has been under consideration, was unsuitable for routine low-level I^{131} measurements on vegetation.

Raw water at the Pasco filter plant was analyzed isotopically and indicated an average of about 5 percent of the maximum permissible concentration recommended by the National Committee on Radiation Protection and Measurement (NCRP).

A detailed report of waste disposal monitoring is contained in HW-50144.

Exposure Evaluation and Records

There were no cases of plutonium deposition confirmed during the month. The total cases on record for the plant is 200. An incident of particular interest occurred at the 234-5 Building which involved a contaminated minor injury. Probing of the wound revealed some grit which was removed by biopsy. Immediate analysis of the skin revealed only 325 d/m; a spot urine sample was also analyzed using the rapid method and was negative.

Process solution which was splashed on an operator's protective clothing during sampling resulted in a technical overexposure of 1.2 rads to a small skin area on the neck.

A biweekly exposure period was established for fast neutron badges. Exposure periods for these meters now coincide with beta-gamma badge film periods for each area. Reduction in material and labor costs will result.

The Home Area assignment and Roving Badge system was initiated on April 15, 1957. This system employs the fact that only one film badge is needed to enter any and all of the plant limited areas. Immediate benefits to be realized by this method

include increased accuracy in personnel exposure records and a reduction in the amount of film to be processed. Long range benefits after complete conversion are an exchange badge system and substantial reductions in badge crew and gatehouse personnel. Complete conversion is dependent upon the rate at which Security can provide tamper-proof passes and is on the order of one year.

The conversion of the entire plant to the new plastic badges was completed during April. The 200-West Area was changed over on April 4; 100-H Area on April 24; and 100-K Area on April 29. The binary film date identification method, originated by Radiological Development Operation, was placed into use. Approximately 1,944 pounds of reclaimed silver were sent to the San Francisco mint during April. The silver shipped to date totals about 3,879 pounds and has an estimated credit value to the Radiation Protection Operation of $41,000. Credit to our operating funds in FY 1957 is reasonably assured.

Radiological Development

A new coding system was developed for dating the badge film by X-ray exposure. A binary code was utilized to specify the week and year the film was worn. Exposure tray shields were designed such that the X-ray operation after the film packet is removed from the badge was eliminated. The new type exposure trays allow the area, date and payroll number to be recorded in a single X-ray exposure. Three exposures were required with the metal badge. The plastic badge design reduced the number of X-ray steps to two. The reduction to a single X-ray step is expected to expedite badge processing and to reduce the chances of film "fogging" due to X-ray. The modified exposure tray shields were put in service late in this reporting period and no operating experience is yet available.

The experimental evaluation of Eastman Kodak Personnel Monitoring Film Type II progressed to the analysis of results. Preliminary observations indicate a marked increase in sensitivity accompanied by an increase in blank background density.

A representative of the Scott Aviation Corporation visited HAPO and demonstrated recent developments in respiratory protective devices. Of prime interest was the new Scott demand regulator system to be used on fresh air masks. This small, light weight device attaches to the exhaust valve of the Scottoramic mask and supplies air to the face piece on demand while also maintaining a constant positive air pressure within the mask. Should a poor face fit or a leak about the face develop, the regulator will supply air continually to the mask and in quantity adequate to maintain the predetermined positive pressure. This new regulator supplies air only while breathing or to replace air lost by leakage. Only two working prototypes of these regulators now exist and the item is not yet on the commerical market. HAPO will consider the applicability of this device when it becomes available and when price data can be obtained.

Specifications and suggested design for a gown type rubber garment were submitted to an interested manufacturer for fabrication of prototypes. These gowns will be fabricated of the previously reported unlined, nylon-reinforced rubber. If acceptable, they will replace the present rubber suits and will offer the features of economy and comfort.

The problems encountered in fabrication of the bioassay flask containers were resolved during a visit to the vendor's facilities. Chrome plated hardware will be substituted for the stainless steel previously specified. The twenty prototype boxes ordered should be delivered during the next month.

[redacted]

A preliminary study of the X-ray dose to the gonads and to the eyes during a diagnostic chest X-ray was completed. The results were summarized and reported by letter to the Manager, Industrial Medical. The measured dose in the vicinity of the gonads was small, about 10 to 35 mr and to the eyes, about 50 mr per exposure. It appeared that the dose could be reduced by collimation of the beam.

Calibrations

At the request of AEC Property Management, a review was made of the radium needs of Hanford Laboratories for the next three fiscal years. This information was compiled and forwarded to the AEC.

Three prototypes of the HGM survey meter were received from the vendor for evaluation. Although in general the units were satisfactory, a number of small discrepancies existed which, if incorporated in the balance or the order, would have resulted in maintenance problems. These discrepancies were resolved satisfactorily.

Three prototype scintillation portable poppies were received from the Eberline Instrument Division for approval. Examination of these units is essentially complete. In general, the units appear to be good; however, several small discrepancies will be resolved with the vendor before completion of the order.

Radiological Consultation

The review of the hazards from the noble gases formed in fission was completed and sent to Radiological Engineering, IPD. This report indicated the importance of the external dosage rate in comparison to the direct radiation dose to the lungs and the build-up of strontiums and cesiums from the noble gas precusors.

Meetings with Industrial Medical and Radiological Physics were held to discuss the problems of estimating the gonad dose to patients from medical procedures at Kadlec Methodist Hospital. Industrial Medical will continue with the compilation of the statistics with numbers and types of examinations while Radiological Physics will later in the year make estimates of the exposure to the gonads from each of these important diagnostic procedures.

Material was submitted to the Atomic Energy Commission for inclusion in the Twenty-Second Semiannual Report of the Commission to Congress. This material consisted of summaries of the important research and development results in the biology and medicine program.

A teletype containing proposed AEC permissible limits for the control of radiation exposure by contractors was reviewed. The comments to the AEC were largely devoted to questions of complying with the proposed limit for the skin dose on the hands and in the problems of monitoring the environs to the extent that would be required to detect a few individuals who could be overexposed.

Documents on the biological experiments with cesium and on the effects of effluents on the Columbia River were reviewed for comment to the authors. In addition, documents on the effects of using phosphoric acid corrosion inhibitor and on the detection of plutonium in wounds were commented upon. The quarterly report of acitivities in the fields of radiological sciences for the division of biology and medicine was prepared in rough draft form for submission to Technical Information for final publication.

A review was started of the information available on the application of the power function to calculations in the field of biology. This document includes the theoretical and philosophical basis on the use of the power function as well as examples of its application with biological data. It is intended that this material be made available for the use of the Subcommittee on Permissible Internal Dose of the NCRP.

In conjunction with liaison with CRAG, assistance was given in formulating responsibilities and plans for control of nonradioactive noxious industrial pollutants from the Hanford plant to the environs. As currently visualized, Industrial Hygiene will be responsible for standards and monitoring, and Chemical Effluents Technology will prepare disposal specifications for guidance of the waste-originating organization, which is ultimately responsible for proper disposal.

Radiological Disaster Studies

Consultations were held with Chemical Effluents Technology on the design of experiments required to measure the rate of release of fission products from uranium under various conditions and at various temperatures. It is intended that these experiments be done originally on a laboratory scale.

Columbia River Studies

Mineral constituents in Columbia River water at 100-F Area for the period January, February, March, 1957, were compiled from IPD Analytical Laboratory reports and transmitted to the Washington State Pollution Control Commission. The unusual river turbidity in February and March was brought to the Commission's attention.

The tabulations of data available on the calculated concentrations of isotopes at Pasco were reviewed and a start made in calculating the values of the fraction of MPC from these numbers for the years 1955 and 1956. These calculations will include the more recent changes in maximum permissible levels recommended by the NCRP and by the recent studies at Hanford.

Radiological Standards

Writing of the second draft of the revision of NBS Handbook 42 was completed and is being prepared for duplicating.

Information on research and practical aspects of exposures to radioactive particulates at Hanford were compiled and sent to other members of the American Standards Association Z-54 Subcommittee on Permissible Contamination Levels of Industrial Materials.

C. EMPLOYEE RELATIONS

Safety

Two medical treatment injuries occurred for an injury frequency of 0.5.

Security

No security violations occurred.

Suggestions

Radiation Protection personnel submitted 14 suggestions in April. One suggestion was adopted for an award of $10. Eleven suggestions were evaluated during the month.

Grievances

No grievances were received in April.

Beneficial Moves

Four beneficial moves occurred.

Training

Revisions and final plans were made in conjunction with Employee Relations for the AEC Radiological Physics Fellows who will spend nine weeks at Hanford this summer.

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented & Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas and Buildings Visited
Robert J. Creagan Robert K. McGeary Abraham Krieg	4-11-57	Westinghouse Electric Corporation Pittsburgh, Pa.	Discuss hazards of handling plutonium.	AR Keene	No	300 Area
WW Grigorieff and Frank Hoecker	4-25-57	Oak Ridge Institute of Nuclear Studies University of Kansas	AEC Physics Fellowship Committee	AR Keene	Yes	100-F:108-F 100-K:105-KE

VISITS TO OTHER INSTALLATIONS

JW Healy	4-11, 12-57	State College of Wash. Pullman, Washington	Attend meeting of Sanitary Engineering Advisory Committee to the State College of Washington	GH Dunstan	No	
FH Sanders	4-12-57	Instrument Labs.	To discuss discrepancies in instrument order.	KG Leigh	No	
LJ Defferding	4-14, 16-57	Pacific Plastic Co.	To discuss discrepancies in equipment order.	Ben Rosen	No	
CM Unruh	4-19-57	State College of Wash. Pullman, Washington	Attend Engineering Open House	GH Dunstan	No	
JW Healy	4-29, 30-57	AEC Project West Los Angeles California	Attend Bio-Medical Program Directors Meeting	CL Dunham	Yes	

REGIONAL MONITORING

The general findings are summarized in the following:

Sample Type and Location	Activity Type	Average Activity Density μc/ml	Trend* Factor
Drinking Water and Related Materials			
Benton City Water Co. Well	alpha	1.3×10^{-8}	--
Richland Wells	alpha	$(1.8 \text{ to } 4.8) \times 10^{-9}$	--
100 Areas	beta	$(0.09 \text{ to } 6.8) \times 10^{-6}$	--
200 Areas	beta	$(0.4 \text{ to } 1.0) \times 10^{-7}$	--
Pasco, Kennewick, McNary Dam	beta	$(0.04 \text{ to } 3.1) \times 10^{-6}$	--
Backwash Solids - Pasco Filter Plant	beta	6.9×10^{-2} μc/gm	--
Backwash Liquids - Pasco Filter Plant	beta	3.4×10^{-6}	-8
Anthracite, Sand Filter - Pasco Filter Plant	beta	1.5×10^{-4} μc/gm	--
Other Waters and Related Materials			
200 West Wells	beta	$<2 \times 10^{-7}$ to 1×10^{-1}	+10
200 East Wells	beta	$<2 \times 10^{-7}$ to 1×10^{-2}	-4
Wells Near 200 Areas	beta	$<2 \times 10^{-7}$ to 4×10^{-7}	--
107 and 108 Wells	beta	$<2 \times 10^{-7}$ to 2×10^{-5}	-10
Outlying Wells	beta	$<2 \times 10^{-7}$	--
Columbia River - Hanford Ferry	beta	2.2×10^{-5}	--
Columbia River - Below Reactors	beta	2.4×10^{-5}	--
Columbia River - Paterson to McNary	beta	9.1×10^{-7}	--
Columbia River - Mud	beta	$(0.16 \text{ to } 2.0) \times 10^{-4}$	--
Raw Water - Operating Areas	beta	$(0.004 \text{ to } 2.6) \times 10^{-5}$	--
Reactor Effluent Retention Basins to River	beta	20,300 to 98,600 μc/sec/r	+2
		$(0.6 \text{ to } 1.8) \times 10^{-2}$	+2
Reactor Effluent Retention Basins to River	alpha	<0.04 μc/sec/reactor	--
		$<5 \times 10^{-9}$	--

* The trend factor shows the n-fold increase (+) or decrease (-) from last month, where values of n less than 2 will not be noted.

Sample Type and Location	Activity Type	Average Activity Density μc/ml	Trend* Factor
Other Waters and Related Materials (contd)			
I-131 in Farm Wastes to River	I-131	1.3×10^{-6}	--
I-131 in Columbia River - Hanford	I-131	9.2×10^{-8}	--
Atmospheric Pollution			
Gross Alpha Emitters	alpha	$(<0.2 \text{ to } 1.2) \times 10^{-14}$	--
Gross Dose Rate - Separations Areas	beta-gamma	0.9 to 4.4 mrad/day	--
Gross Dose Rate - Residential Areas	beta-gamma	0.2 to 0.6 mrad/day	-6
Active Particles - Separations Areas	beta	$(0.5 \text{ to } 2.4) \times 10^{-13}$	-2
I-131 Separations Areas	I-131	$(0.9 \text{ to } 6.7) \times 10^{-13}$	--
I-131 Separations Stacks	I-131	1.1 curies/day	--
Ruthenium - Separations Stacks	Ru-103-106	<0.02 curie/day	--
Active Particles - Wash., Idaho, Ore., Mont.	--	0.008 to 0.054 ptle/m^3	--
Active Particles - Project	--	0.005 to 0.048 ptle/m^3	+3
Vegetation			
Environs of Separations Areas	I-131	$(<0.6 \text{ to } 2.9) \times 10^{-5}$ μc/gm	-2
Residential Areas	I-131	$(<0.6 \text{ to } 1.1) \times 10^{-5}$ μc/gm	--
Eastern Washington and Oregon	I-131	$< 6 \times 10^{-6}$ μc/gm	--
Non-Volatile Beta Emitters Wash. and Ore.	beta	$(0.1 \text{ to } 4.0) \times 10^{-3}$ μc/gm	+3
Alpha Emitters - Separations Areas	alpha	$(0.3 \text{ to } 9.5) \times 10^{-7}$ μc/gm	--

* The trend factor shows the n-fold increase (+) or decrease (-) from last month, where the values of n less than 2 will not be noted.

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RADIATION MONITORING

	Hanford Laboratories	Construction Engineering	Others	April Total	1957 To Date
Special Work Permits	2,324	711	262	3,297	10,336
Radiation Surveys	1,486	1,084	364	2,934	10,938
Air Samples	2,223	199	134	2,556	8,912
Skin Contamination	7	11	0	18	78
*Class II Radiation Incidents	0	0	0	0	0
**Class II Radiation Incidents	0	0	1	1	1

EXPOSURE EVALUATION AND RECORDS

Gamma Pencils	Pencils Processed	Paired Readings 100-280 mr	Paired Readings Over 280 mr	Lost Readings
April	277,640	21	9	11
1957 to Date	1,086,864	52	46 (1)	42 (1)

Beta-Gamma Film Badges

	Badges Processed	Readings 100-300 mrads	Readings 300-500 mrads	Readings Over 500 mrads	Lost Readings	Average Dose Per Film Packet mrad(ow)	Average Dose Per Film Packet mr(s)
April	56,868	734	25	2	89	1.72	3.21
1957 to Date	213,143	2,530 (2)	71	20	286	1.76	2.98

Slow Neutron Pencils

	Pencils Processed	Paired Readings 4-12 mrem	Paired Readings Over 12 mrem	Lost Readings
April	2,546	30	1	1
1957 to Date	9,398	95	19	5

Fast Neutron Film Badges

	Badges Processed	Readings Above 50 mrem	Lost Readings
April	1,048	0	2
1957 to Date	3,986	0	3

Bioassay

	April	1957 to Date
Plutonium: Samples Assayed	1,290	5,011
Results above 2.2×10^{-8} µc/sample	24	127 (1)
Fission Product: Samples Assayed	1,368	5,526
Results above 3.1×10^{-5} µc FP/sample	0	5
Uranium: Samples Assayed	361	1,563

*Radiation Monitoring Operation Customers
**Total Plant

(1) Corrected total.
(2) Includes 65 exposures to construction personnel not previously reported.

Uranium Analyses	Following Exposure Units of 10^{-9} µc U/cc			Following Period of No Exposure Units of 10^{-9} µc U/cc		
Sample Description	Maximum	Average	Number Samples	Maximum	Average	Number Samples
Fuels Preparation	6.56	2.02	55	4.35	1.45	37
Hanford Laboratories	7.95	2.56	16	9.21	2.21	14
CPD - Finished Products Uranium Reduction	9.14	3.53	110	9.33	2.65	104
Special Incidents	0	0	0	0	0	0
Random	2.21	2.21	1	--	--	--

Tritium Analyses	April	1957 to Date
Samples Assayed	23	24

Thyroid Checks		
Checks Taken	27	154
Checks Indicating .01 µc	1	1

Hand Checks		
Checks Taken - alpha	53,101	213,487
- beta-gamma	51,386	203,691

CALIBRATIONS

Portable Instrument Calibration	Number of Units Calibrated April	1957 to Date
CP Meter	1,129	4,287
Juno	384	1,513
GM	1,494	5,698
Other	202	753
Total	3,209	12,251

Personnel Meters		
Badge Film	1,968	8,886
Pencils	4,941	12,012
Other	179	793
Total	7,088	21,691
Miscellaneous Special Services	247	1,559
Total Number of Calibrations	10,544	35,501

A. R. Keene, Manager
RADIATION PROTECTION

ARK:bh

[redacted]

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LABORATORY AUXILIARIES OPERATION MONTHLY REPORT - APRIL, 1957

General

Safety performance of the Operation, as indicated by the Minor Injury Frequency Rate was within control limits and about the same as for March. A near serious injury occurred when an employee who was operating a lathe failed to tighten the chuck jaws sufficiently to hold the work when rotation started. The work, which consisted of a 6" flange, struck the employee causing minor lacerations. Investigation revealed the need to modify the job hazard breakdown, although careful attention to the breakdown would have prevented the injury but not the accident.

The absenteeism rate for all employees was down to 3.9% which is substantial improvement over March but is still well above the expected frequency. Investigation of March results indicated a large number of cases of flu.

For the second successive month there were no security violations reported for this Operation.

There were no grievances filed during the month and there are none pending reply.

Facilities Engineering Operation

Preliminary work is progressing on the functional charts for use in Facilities Engineering Operation. These charts will give a graphic display of the flow of work within each group.

Plans are being initiated and information accumulated for preparation of a service bulletin which will state the various activities which Facilities Engineering Operation is capable of providing to potential customers.

The standard of performance is increasing in the area of small job items ranging in cost up to $20,000.

Economy measures have been exercised in the Landlord and Building Engineering function. Maintenance work has been restricted to a minimum level consistent with safety and protection of structures and facilities.

The economy measures of HLO have affected the Drafting Operation. Plans are being formulated to maintain or better the standard of performance of that operation. One of the plans being investigated is the establishment of a fixed price per drawing produced. This will alleviate the apparent problem of customer requests for the higher rated draftsmen.

The Project Planning and Scheduling group has initiated the preparation of project proposals within the operation as time permits. The results indicate satisfactory performance.

Efforts and plans are being directed toward reducing the present work load in the Materials and Standardization group. The results of this effort will be toward better utilization of available manpower on Project and Capital job items, thus effecting savings in overhead costs.

Attached is the summary of project work for Hanford Laboratories Operation.

The Project Status Report was issued to all Level 3 and 4 Managers and a project review meeting has been set up for May 9. At that time a determination will be made as to whether these meetings will be held on a monthly or bi-monthly basis, depending upon the desires of those concerned.

Efforts have been directed toward the preparation of a design criteria for the Radiochemistry Hot Cell. Preparation work is 85 per cent complete to date. Review of the preliminary work will be made and approved criteria is planned to be submitted to Construction Engineering Operation by May 15.

It has been decided to install Kaiser Aluminum shade screens or equal on the exterior of the windows on the second floor of the 3760 building. Efforts are being made at this time for the procurement and installation of these screens. The extreme temperatures in this building recently are not due only to the solar heat gain, but a leaky steam valve and an air washer pump under repair also contribute somewhat to this condition. However, the summer cooling for this building has always been unsatisfactory and it is intended to make permanent modifications to the system.

Construction Engineering Operation is now conducting studies for correction of heating problems in buildings 746, 306, 326 and 328.

Difficulty has been encountered with the bearings on the ventilating fans in 306 building. Efforts are being made toward replacement of the failed sleeve bearings with ball bearings in accordance with the fan manufacturer's recommendation.

Material on the Breathing Air System to be installed in the 141-FS building has been forwarded to the 100-F Area Work Review Committee. If it is decided to use plant forces it should be recognized that the installation of this system will be dependent upon Project CG-558 which is expected to occupy the forces until the end of May.

The Formaldehyde System for 146-FR building is being reviewed. The start of construction work if plant forces are used will again be dependent upon Project CG-558.

The vacuum Air Sampling System in the 108-F building has been started and is being designed by Facilities Engineering Operation. Limited space in the mechanical room on the first floor may result in the installation of a multiple pump system.

Conversion of the electrical wiring in the 146-FR building has resulted in an informal request and this proposal has been submitted requesting General Plant funds in the amount of $8,000.

Work is progressing on the Degreaser Crane in 328 building. Installation will be made during the month of May.

The Shielded Cave in 325 building being procured and installed under Appropriation Request 57-HL2-47 is progressing as follows: the authorized amount for this work is $21,330; expenditures and commitments to date total $11,707; the work is estimated to be 42 per cent complete.

Work is starting on the following job items:

1) Air conditioning system in the Radiographic Testing Laboratory, 224-B building.
2) Top soil for the Animal Farm in 100-F Area.
3) Addition to the 141-H building.

The Drafting and Design operation produced approximately 215 drawings and revisions with a total productive effort of 2663 man hours. Approximately 9500 sq. ft. of prints were reproduced on our ozalid machine. Drafting and Design personnel are located in the 3706 building with one person located in each of the following buildings - 327, 231-Z, 1704-D and 2704-C. Backlog of work in the 300 Area is low - 30 to 40 days - but only indicates that work actually on the records in the drafting room. Engineers are waiting until a Draftsman or Designer of their choice is available before starting their work. This is a problem, and efforts are being made to correct it as previously discussed.

Work was initiated for the preparation of a shop practices and tolerances guide book. This work is being performed by the Drafting Operation in cooperation with Technical Shops.

Significant Reports Issued -

Routine - Plans are being effected resulting in the deletion of certain reporting in the nuclear materials area. This work will be transferred to Financial Operation.

a) Report of HLO Requirements for Nuclear Materials Inside Production Channels.

b) Laboratory Auxiliaries Operation Quarterly Inventory Report for Reactor and Other Special Materials.

c) Quarterly Report of Requirements Study for HLO per AEC Bulletin #17.

Non-Routine -

a) Status report of all outstanding Zirconium orders for HLO.

b) Survey of HLO Gallium requirements.

c) Surveys for the AEC on Radium Isotopes and Bismuth.

Efforts toward filling vacancies for qualified Engineers in FEO have not resulted favorably. Interviews were held with potential candidates available from IPD.

However, we have not been successful in obtaining personnel from this source as yet. We were notified that the Electrical Engineer interviewed during the month of January has accepted our offer and will report to work during July.

Three technical graduates on rotation were interviewed; one has requested assignment with FEO and will report on May 1.

Mr. K. H. Hammill joined FEO on April 1 and is presented engaged in the preparation of criteria for the Radiochemistry Hot Cell.

Laboratories Administration

Thirteen additional Organization and Policy Guides were issued. A total of 145 have been issued and 43 are in draft form or ready for duplicating and distribution. Timely revisions have been issued on specific sections of six existing Guides.

The following contract was entered into in April:

Consultant Agreement No. CA-159 M. E. Ensminger

Requests for a used pickup truck and a used motor scooter were submitted to Transportation and Maintenance Operation resulting in a motor scooter being assigned. Available used equipment was assigned in accordance with two prior requests. Two sedans were re-assigned to extend the useful service period of these vehicles. Joint usage of one component's vehicles with another component was arranged; hence, the need for an additional vehicle was eliminated. A further justification was prepared and transmitted to Transportation and Maintenance Operation in support of the FY-1958 and FY-1959 budget for transportation and heavy equipment.

There were no new requests for service under the Assistance to Hanford and KAPL programs. A draft letter to the Hanford Operations Office was written and circulated for approval requesting authorization for the Assistance to Hanford Program for FY-1958.

The individual needs for Top Secret clearance for personnel of Laboratory Auxiliaries Operation were summarized in accordance with the new security categories.

Radiographic Testing Operation

A new record of activity for the Radiographic Testing Operation was realized this month; a record total of 1191 tests was achieved. Of the total number, 891 tests were radiographic exposures (including x-ray and gamma-ray exposures), and the remaining 300 tests were supplementary tests. The supplementary tests included boroscope, eddy current, dye penetrant, and ultrasonic tests. Work was done for fifteen different organizational components, encompassing all of the manufacturing departments and each of the supporting operations. Reports issued detailing test findings, with conclusions and recommended action, totalled eleven. The Radiographic Testing Operation was consulted on six different occasions for advice and information regarding general testing theory and applications for other than the jobs tabulated.

Two large process vessel jobs involving Class I vessel fabrication were started this month. One was the L-cell package for Purex. This includes considerable stainless steel piping and a number of small vessels. Two condensers, partially completed, were examined. It is anticipated that this work will extend over a three-month period. The other vessel is a Redox slug dissolver. Because of the severe service to which this vessel is subjected it is made out of 3/4-inch thick stainless steel. A special cone-shaped bottom also complicates the fabrication.

Stainless steel welding on the plant received somewhat of a set-back due to the short supply of welding grade argon caused by strikes. As a substitute for purging gas, nitrogen was suggested and is being used. Considerable work was done, both in the shop and the field, examining welds made with a nitrogen purge. The fears expressed as to possible deleterious effects on weld soundness (increased susceptibility to cracking, decreased ductility) were proved to be unfounded by the shop welds. It was found, however, that under field conditions adequate purging was not being achieved in all cases, and some severe oxidation was occurring on the back of the weld.

With the advent of new fuel element geometries, the Fuels Preparation Department is seeking new production tests to assure integrity of these elements. To assist them in their correlation on I & E cap spires, a large group of spires was examined for side wall discontinuities. The radiographic evidence obtained (laps and inclusions) will be used to correlate eddy current test indications.

Work was done on two new fuel element types: one UO_2 swaged in zirconium cans; the other, a uranium wafer slug. Compacting and location of the UO_2 was determined for the first. This examination allowed exact cutting of zirconium end plugs and also checked the integrity of the seal. In the case of the wafer slug it was desired to check on the cocking or other displacement of the individual wafers and also the extent of Alsi fill. To do this, a gamma-source was passed through the internal core of the slug, exposing film wrapped around the outside. Preliminary pictures indicated this technique had some merit.

Pressure vessel work continued with two small jobs. One was the finishing of an organic storage tank. Repair welding was examined and passed. This vessel was a landmark in that it was the first to be manufactured under HAPO's "Certificate of Compliance" and bears the ASME Code Stamp. Spot checking was also done on the welding in a stainless steel high-temperature, high-pressure loop system.

In the zirconium process tube program, two sets of development tubes were evaluated as completely as possible with existing equipment and facilities. The tests included 100 per cent x-ray examination (single-wall), 100 per cent dye penetrant (outside surface), 100 per cent eddy current (internal probe), partial boroscope examination (to corroborate other test findings), visual, and dimensional checks. One set showed extreme wall thickness variations that were traceable to final sizing operations. In the other set where a different operation was used, trouble was also experienced from die cleanliness. This last set also had an unusual condition of heavy metal inclusions along one rib. From the eddy current indication the inclusions appeared to be metallic. The radiographic density did not favor tungsten, indicating some lighter material, possibly an oxide. Glass lubricant inclusions would also be possible, but were not favored by the strong eddy current indication.

A series of plutonium alloy castings made with different matrix alloys were radiographed. Centerline shrink, cavities, gas porosity, and hot tears were found in the castings to various degrees. However, it was possible to select sound material. Zirconium cans and caps (machined from solid stock) were fortunately also examined, and defective material detected and removed. The canned components were given a final examination for integrity of the closure.

Ultrasonic thickness measurements on the water piping between 190 and 105 in the 100-D Area was started this month. It is hoped that something can be learned of the condition of the older piping since there is some evidence indicating reduction of wall thickness by corrosion. Two lines are being examined, one in the north tunnel and one in the south, to obtain a preliminary picture of what might be expected.

A small development program was started for Relations and Utilities, Electrical System Planning, to evaluate the possibility of detecting power pole deterioration below ground using a radioactive source. Radiographs of a rotted pole showed that the decay pattern could easily be discerned. Two tubes will be driven down alongside the pole 180° apart. With a source in one, and a detector in the other, a scan will be made of the pole from its bottom to ground level. The resulting trace should give a density profile from which the condition of the pole can be deduced.

Distribution of work performed during the month is as follows:

Customer	No. of Tests	Ft. of Weld or Material	No. of Pieces	Description
Chemical Processing Department	120	22	32	S.S. pipe and process vessel welds.
Construction Engineering Operation	165	98	47	S.S. pipe and process vessel welds.
Fuels Preparation Department	30	216	300	Al cap spires.
Irradiation Processing Department	168	1	14	Ultrasonic thickness measurements.
Hanford Laboratories Operation	695	367-1/2 14 sq. ft.	136	Zr tubing, Pu alloys, U fuel elements and misc. materials.
Relations & Utilities Operation	13	5-1/2	2	Wooden power poles.
Totals	1191	723-1/2 14 sq. ft.	531	

Technical Shops Operation

Total productive time for the month was 13,085 hours. The total shop work backlog is 19,026 hours which is a slight increase over the previous month. Overtime worked during the month was .9% (164 hours) of the total available hours.

Distribution of time was as follows:

	Man Hours	% of Total
Fuels Preparation Department	1986	15.2
Irradiation Processing Department	3354	25.6
Chemical Processing Department	1493	11.4
Hanford Laboratories Operation	5892	45.0
Construction Engineering Operation	75	.6
Miscellaneous	285	2.2

Customer demands for service remained firm in all components of the operation. The reduced level of service requested by Hanford Laboratories was offset by increased demands for service by the Irradiation Processing Department.

A suggestion award of $850.00 was given to H. T. Benjamin, an employee of the operation, for suggesting a new method of plugging cored fuel elements. This was the largest award ever received by an employee of the operation.

Motion pictures of the pressurized magazine reactor charging machine under simulated operating conditions were completed by engineers from the Irradiation Processing Department. Current plans are to deliver this equipment to a reactor area sometime during the current month.

The physical inventory of shop material assigned to the operation was completed and reconciliation showed the actual value of the material to be $7,000.00 in excess of the book value. This average is primarily due to rising prices and the inclusion of excess customer material in the physical count.

Technical Information Operation

The number of personnel in Technical Information Operation will be reduced for FY 1958. This reduction forecasted necessitates a thorough review of the Operation's present activities to decide whether to completely eliminate some services, or retain the same spectrum of services but reduce them in quantity and quality. It is expected that the result of the questionnaire on Technical Information services will aid in making the best decision.

Two projects which have been under way for a couple of months are nearing completion. (1) The questionnaire on Technical Information services is being printed, and will be distributed to exempt personnel early in May. (2) The brochure on Technical Information reference resources and services has been edited to incorporate a number of useful suggestions received from those who read the first draft. It will be illustrated by a member of the Library staff.

A steady rise in IBM costs makes it important to determine if the present method of handling Files activity through the IBM 702 machine is yielding sufficient benefit to justify the money spent. The Specialist, Technical Information

Procedures, has recommended a drastic curtailment of services now being purchased from the Data Processing Operation. Her recommendations are being studied by the Specialist, Office Procedures, HLO Financial Operation.

The work volume in the Library continued the steady increase which began with the reorganization. Book and periodical circulation were the highest ever recorded for a single month. The number of new volumes ordered was very near the previous high.

A decision was made to change the plant Library's circulation procedure so that only one charge card is used instead of two. This will simplify the charge-out procedure and shorten the time required to prepare a book for circulation.

Almost all the basic indexes of Classified Files activity increased during the month of April.

The quarterly inventories for April were generally satisfactory. A few contained minor errors due to an out-of-sequence condition on the tape. It is hoped that this high level of accuracy can be maintained. By arrangement with Security, future inventories will not show charges from Files of CONFIDENTIAL - UNDOCUMENTED documents.

The inventory of Files' holdings is progressing steadily. During the month a total of 11,457 GEH, HP, HPX and HDC copies were inventoried. Also, the inventory of documents in Records Center was started. Lists of the contents of 95 storage boxes were requested. To date 2,979 documents have been inventoried and accounted for. IBM cards for documents routed to Records Center were reproduced and sent to Records by Data Processing.

Three hundred ninety-nine copies of "Confidentially Yours" were distributed to the field during the month. The Specialist, Technical Information Procedures, held information meetings with 64 secretaries and clerks in five Areas. Their comments regarding the revised edition were very favorable. Three more Area meetings are planned for the first part of May. The Supervisor, Document Accountability, and a representative of Security attended the meetings to help answer questions.

Satisfactory progress was made on four bibliographies during the month.

1. The survey on the effects of neutrons on metals was completed.
2. Ninety abstracts were prepared for the HAPO contribution to the plutonium handbook.
3. The subject index for the 300 Series Production Test Bibliography has been completed and will be typed on duplimats after review and approval.
4. Approximately 30% of reports intended for inclusion in the corrosion bibliography have been abstracted.

Two important reports prepared primarily for internal use at HAPO were issued:

HW-36713, Rev. 2 "Guide to Atomic Weapon Data at Hanford"
HW-48000 "Dosimetry of Plutonium Fabrication - Terminal Report"

A study has been in progress during recent months to determine the maximum reproducibility that can be obtained by the halftone method with HAPO facilities. The objective is to reduce the number of photographs now reproduced as glossy prints, and to use the cheaper halftones whenever possible. Samples of photomicrographs reproduced at Printing were discussed with a representative of Eastman Kodak and with personnel of Fuels Development Operation in attempts to reconcile authors' requirements and process limitations. Information gained so far will permit finer choice of reproduction process, with expected savings of several thousand dollars per year.

Selection and review of HAPO documents for the Industrial Irradiated Fuel Processing Program has been completed, and the final list was mailed to the Hanford Operations Office on April 25. A total of 287 documents were selected; only 25 of these were not already in the Commission's files, and these are being sent to TISE.

All existing sections of the Hanford Classification Guide have been revised to reflect the changes made by the Divisions of Classification and Production. The revised sections are in the hands of the HOO Classification Officer for final review and approval prior to reproduction and distribution to plant personnel. It appears that the demand for copies of this guide may greatly exceed the 200 copies originally planned.

Two additional sections will be included in the guide. One section will include the Unclassified Fields of Research; the other will include the Official Security Codes at Hanford.

Memoranda on classification which were distributed to the field are as follows:

1. "Classification of AEC-325 Forms"
2. "Classification - Hanford Production Data", HW-49449
3. "Classification: Fuel Element Manufacture"

Work Load Statistics

	March	April
Documents routed and discharged	29,414	34,390
Documents issued	10,367	9,727
Documents destroyed	6,442	6,673
Reports abstracted	309	225
Formal R & D reports issued	8	6
Document classification changes	451	644
Books circulated	2,287	3,173
Periodicals circulated	12,184	14,193
Volumes added to the collection	313	441

J L Boyd

Manager,
LABORATORY AUXILIARIES

JL Boyd:po

MONTHLY PROJECT REPORT

HANFORD LABORATORIES OPERATION

PROJECT NUMBER	TITLE	USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED / ACTUAL	STARTING DATE DESIGN / CONST.	BENEFICIAL USE DATE	PROJECT COMP. DATE DESIGN / CONST.
General AEC-2-23X-56-L-2	Plant Projects - FY 1956,	Reactor & Fuels	$140,000	$140,000* 4-4-57	100 100	2 2	5-23-56 12-7-56	As Completed	9-28-56 5-1-58
CG-664	350° C Flow Loop - 314 Bldg.								

REMARKS: A revised work authority was received for this project, authorizing additional funds of $20,000 for a new total of $140,000, fabrication by a Labor Service Contractor and extension of the directive completion date to May 1, 1958. Total number of requisitions and/or orders placed for equipment and special materials is twenty-four, with an estimated total value of $52,000.
*Includes $350 transferred equipment.

General AEC-2-23-57-N-2	Plant Projects - FY 1957,	Radiation Protection	$150,000	$150,000 2-4-57	100* 100*	Not Schd. 0	2-18-57 7-30-57	12-31-57	6-1-57 12-31-57
CA-658	Shielded Personnel Monitoring Station (747 Building Addition)								

REMARKS:
The U. S. Navy has not yet released the 7¼ inch flat steel plate at Arco for use by the AEC. The Commission is currently negotiating with a group of A-E's prior to awarding a contract for design of the facility.

*Scope Only

CG-680	Corrosion Testing Facilities - 314 Bldg.	Reactor & Fuels	$135,000	$29,500* 9-24-56	100 100	To be est. 0	10-3-56 1 mo.**	9 mo.**	1-25-57 10 mo.**

REMARKS: A revised project proposal was reviewed by HOO-AEC on April 25, 1957 to request construction funds, indicate minor changes in scope and decrease total project cost. Plans and bid package information are being readied for immediate issue upon proposal approval. The stainless steel tank has been ordered. **After Author'n.
*Interim authorization only for design and procurement. Total cost of project is $166,000, including $31,000 transfer of capital equipment.

CA-685	Alterations to Buildings 325 and 326	HLO	$23,000	$23,000 10-4-56	100* 100*	60 58	10-1-56 4-9-57	As Completed	11-14-56* 8-15-57

REMARKS: 325 Bldg. Partial shipment of elevator door components were received at Pasco. Construction still scheduled to start June 15, 1957.
326 Bldg. Contracted work complete except for stair treads and balcony light. Contractor has been asked to submit a price for altering present contract to include construction of a wall on the exposed portion of the stairs and altering the north door.

CA-700	Geological and Hydrological Wells	Chemical Research	$137,000	$137,000 10-24-56	100 100	No Sched. 25	11-8-56 10-24-56	As Wells completed	1-15-57 12-10-57

REMARKS:
USGS Wells - Three wells completed. Drilling in progress on wells 299-W-19-1 and ~~299-E-24-8~~. 1824 ft. of hole (48%) completed.

Fixed Price Wells - All 3 wells of Group 1 completed. Drilling in progress on wells (#2) 699-78-62 and (#6) 699-74-44. Contract 11% completed. Schedule of Construction to be submitted for Fixed Price wells only.

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MONTHLY PROJECT REPORT

UNCLASSIFIED

HANFORD LABORATORIES OPERATION

PROJECT NUMBER	TITLE	USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION: AMOUNT / DATE	PROJECT PROGRESS IN PER CENT: DESIGN SCHED / DESIGN ACTUAL	PROJECT PROGRESS IN PER CENT: CONST. SCHED / CONST. ACTUAL	STARTING DATE: DESIGN / CONST.	BENEFICIAL USE DATE	PROJECT COMP. DATE: DESIGN / CONST.
CA-728	High Level Exposure Facility Addition - 141-H Bldg.	Biology Research	$26,000	$26,000 / 2-11-57	Not Schd. / 0	Not Schd. / 0	3-11-57 / 9-15-57	12-11-57	7-15-57 / 1-11-58
		REMARKS: Design criteria submitted to Commission. Gray and Osborne, Yakima, Washington were awarded the A-E contract. No design schedule has been submitted to date.							
CG-729	Ventilation System Improvements 222-U Building	Chemical Research	$73,000	$73,000 / 3-12-57	40 / 40	0 / 0	4-23-57 / 1-12-58	6-12-58	6-12-57 / 9-15-58
		REMARKS: Five comment prints were issued on the ventilation system. The Commission verbally approved a request that plant forces rehabilitate the counting room refrigeration system.							
B-5776	Effluent Engineering Test Facility	Chemical Research	$152,000	Pending / Pending	To be est / 0	To be est / 0	To be est. / To be est.	To be est.	To be est. / To be est.
		REMARKS: Chemical Research and Development Operation withdrew the Project Proposal and Plant and Equipment Analysis Report. Project will be deleted from future reports.							
CG-733	Plutonium Metallurgy Facility Expansion	Research & Fuels	$295,000	$16,000* / 3-7-57	40*** / 40***	To be est. / 0	1 mo.** / 1 mo.**	As Completed	4½ mo.** / 13 mo.**
		REMARKS: Preliminary design is being prepared by CEO. Upon approval of preliminary design by CEO, HLO and HOO-AEC additional funds will be released by AEC for decontamination, construction and design work. *Interim Authorization. **After authorization. ***Scope Only.							
	Coolant Radio-Analysis Laboratory Addition, 1706-KE	Chemical Research	$77,500	None to date / None to date	To be est / To be est	To be est / To be est	1* / 7*	12*	4* / 13*
		REMARKS: Project proposal is undergoing approval in Hanford Laboratories Operation. * Months after authorization.							

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MONTHLY PROJECT REPORT

HANFORD LABORATORIES OPERATION

HW-49752
APRIL 1957

PROJECT NUMBER	TITLE	USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION	PROJECT PROGRESS IN PER CENT		STARTING DATE	BENEFICIAL USE DATE	PROJECT COMP. DATE
				AMOUNT / DATE	DESIGN SCHED / ACTUAL	CONST. SCHED / ACTUAL	DESIGN / CONST.		DESIGN / CONST.
	Biology Controlled Activity Water System 100-F Area	Biology		Pending	100	To be est	Jan. 1957		4-11-57
		Research	$19,900	Pending	100	0	1 mo.*	6 mo.*	6 mo.*
		REMARKS: Informal Requests prepared and currently awaiting review of the cost estimate by Estimating Operation, before routing for approvals. *After authorization.							
IR-222	Aquatic Biology Raw Water System 100-KE Area	Biology		$8,900	100	0	1-2-57		4-30-57
		Research	$8,900	4-8-57	100	0	4-20-57	10-8-57	7-1-57
		REMARKS: Informal Request IR-222 dated 3-12-57, was approved by HOO-AEC on 4-8-57. WRA #18 authorized full project funds to HLO. Work Order #A-57760 authorized Construction Operation $7,000 for construction and installation of the system.							
Equipment Not Included in Construction Projects, FY 1956		Reactor &		$120,000	100	0	5-1-56		4-1-57
		Fuels	$120,000	2-7-57	100	0	6-1-57	8-31-57	9-30-57
		REMARKS:							
CG-620	Vacuum Furnace	A bid package is being prepared for the lump sum bid for the installation of the equipment. Vendor inspection personnel is visiting the fabrication shop this month.							
Equipment Not Included in Construction Projects, FY 1957		Reactor &		$135,000	100	0	3-27-56		4-1-57
		Fuels	$147,000	3-15-57	100	0	8-1-57	12-31-57	12-31-57
		REMARKS: Placement of purchase orders and requisitions for engineered equipment are 95% complete. Following receipt of no bids by the scheduled April 15, 1957 bid opening date an extension of bid time to May 2, 1957 was granted. Four bids have been received to date.							
CG-661	Additional Heat Generation Facility - 189-D Bldg.	Reactor		$22,400*	25	To be est	12-6-56*		13**
		& Fuels	$664,000	11-13-56	27	To be est	15**	23**	23**
		REMARKS: A revision to the proposal for construction funds is being routed in HLO for approvals. Design is continuing but can only go as far as 30% before vendor information is needed. *Interim authorization for preliminary and detailed design. ** Months after authorization.							

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MONTHLY PROJECT REPORT

HANFORD LABORATORIES OPERATION

PROJECT NUMBER	TITLE	USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED / ACTUAL	STARTING DATE DESIGN / CONST.	BENEFICIAL USE DATE	PROJECT COMP. DATE DESIGN / CONST.
CG-672	Monochromatic Neutron Beam Facility - 105-KE Bldg.	Physics & Instr.	$195,000	$195,000 / 3-7-57	100 / 100	0 / 0	5-21-56 / 10-1-57	6-1-58	10-1-56 / 5-1-58
		REMARKS: No change in status since last report has occurred. Materials on order are scheduled for delivery in late summer and fall.							
CA-681	Hanford Equipment in the ETR	Reactor & Fuels	$1,200,000	$600,000* / 2-8-57	96 / 98	No Schd. / 10**	9-17-56 / 6-15-57	*	5-29-57 / 8-15-58
		REMARKS: Revision No. 2 to the project proposal, requesting approval of the additional $600,000 is being routed for approval signatures within HLO. Procurement is continuing. 60 requisitions, with an estimated value of $343,000 have been issued to date. Total value of quotations accepted is $39,450. *GE $550,000, AEC $50,000 for partial procurement and complete design. **Procurement only reported.							
CG-682	High Level Cut Off and Examination Cell - 327 Bldg.	Reactor & Fuels	Not Est.	$30,500 / 2-1-57	68 / 68	0 / 0	7-18-56 / 6-57	*	6-26-57 / Not est.
		REMARKS: Design continuing on schedule. Design costs are as estimated to date. Currently adjusting height of cut off box and viewing window for maximum operating efficiency. *Directive HW-390 Modification 1 authorized GE an increase in design funds for the rescoped cell. Interim authorization for design only.							
CA-695	Radio Telemetering Network	Physics & Instr.	$89,000	$89,000 / 1-10-57	100 / 80	Not Schd. / 0	2-21-57 / 7-25-57	4-15-58	4-25-57 / 5-15-58
		REMARKS: Delay of preparation of specifications by CEO, caused by higher priority work, resulted in failure to meet the 4-25-57 design criteria completion date. Specifications distributed for comment. Criteria to be completed early in May.							
New Construction - FY 1958		Reactor & Fuels	$3,600,000	None to date / None to date	To be est / 0	To be est / 0	3 mo.** / *	*	10 mo.** / *
CG-744	Metallurgical Development Facility	REMARKS: Project proposal for $60,000 for preliminary design and initiation of detailed design has been approved by HOO-AEC and sent to Washington, D. C. AEC for approval. *To be established after scoping is performed. **Detail design only.							

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MONTHLY PROJECT REPORT

HANFORD LABORATORIES OPERATION

PROJECT NUMBER	TITLE	USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED / ACTUAL	STARTING DATE DESIGN / CONST.	BENEFICIAL USE DATE	PROJECT COMP. DATE DESIGN / CONST.
CG-747	Plutonium Fabrication Pilot Plant	Reactor & Fuels	$4,000,000	$100,000 / 4-12-57	1 / 1	To be est. / 0	4-19-57* / To be est.	To be est.	10-19-57* / To be est.
		REMARKS: AEC Directive No. HW-429 dated April 12, 1957 authorized G.E. $100,000 for preliminary design and directed General Electric to submit a site survey report and a project proposal requesting total project funds by May 15, 1957 and June 1, 1957 respectively. Site study and project proposal preparation were initiated. Development of enclosures or hoods for fabrication machinery was specifically excluded from the authorization. *Preliminary work only.								
	Organic Coolant Test Loop in the ETR	Reactor & Fuels	$750,000	None to date / None to date	To be est / To be est	To be est / To be est	* / To be est.		* / To be est.
		REMARKS: A project proposal for $107,000 in design funds was recalled from the General Manager's office until FY 1958. *Scoping & Preliminary Design, Start 2 mo. and complete 4 mo.; Det. Design, start 4 months and complete 11 months after authorization.								
CG-731	Critical Mass Laboratory	Physics & Instr.	$2,000,000	None to date / None to date	To be est / 0	To be est / 0			
		REMARKS: The project proposal was returned unapproved from AEC. Further study of alternatives is being conducted prior to preparation of a project proposal for 1958 fiscal year funds.								
CA-749	High Level Radiochemistry Cell	Chemical Research	$800,000	None to date / None to date	85* / 85*	To be est. / 0	4-1-57* / 7 mo.**	19 mo.**	5-15-57* / 18 mo.**
		REMARKS: A project proposal for $62,000 for preliminary design and scoping funds has been submitted to HOO-AEC for approval this month. A design criteria is being prepared and is essentially 85% complete. *Design Criteria Only. **After authorization of detailed design.								
	Additions to the 314 Bldg.	Reactor & Fuels	$50,000	None to date / None to date	To be est / To be est	To be est / To be est	To be est / To be est.	To be est.	To be est. / To be est.
		REMARKS: A project proposal is being prepared by CEO on this project. Original scope estimate indicated a total project cost of $65,000. The scope of work is being reduced to limit total project cost to $50,000.								

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MONTHLY PROJECT REPORT

HANFORD LABORATORIES OPERATION

HW-49752
APRIL 1957

PROJECT NUMBER	TITLE	USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED / ACTUAL	STARTING DATE DESIGN / CONST.	BENEFICIAL USE DATE	PROJECT COMP. DATE DESIGN / CONST.
	Expansion of the 3745-B Bldg.	Physics & Instr.	Not Determined	None to date / None to date	To be est / To be est	To be est / To be est	1 mo.* / 9 mo.*	16 mo.*	6 mo.* / 16 mo.*

REMARKS:

A project proposal is being prepared for this project by CEO. Higher priority work has been responsible for the delay in completion of this proposal.

*After authorization.

REMARKS:

REMARKS:

REMARKS:

REMARKS:

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LABORATORY AUXILIARIES OPERATION
APRIL, 1957

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented & Address	Reason for Visit	H.W. Personnel Contacted	Access to Restricted Data	Areas and Buildings Visited
B. L. Baird	4-24-57	North Am. Aviation Co., Los Angeles, Calif.	To present paper on welding thin sections of titanium, zirconium, and stainless materials.	G. A. Conner W. E. Roake E. B. LaVelle R. B. Socky	None	760 Bldg. 700 Area

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
K. R. Rimington	4-11-57	Star Machinery Co. Seattle, Washington	Confer with Lodge & Shipley factory representatives on maintenance and set up problems, and to attend demonstration of Lodge & Shipley equipment.	P. Berner	None
R. B. Socky	4/2-3/57	Western Pneumatic Tube Co., Seattle	To consult and examine testing facilities for titanium and zirconium tubing.	Production Manager	None
R. B. Socky	4-26-57	Vancouver Chapter ASM. Vancouver, Wash.	Attend Chapter Meeting.	J. McCulloch	None

Manager,
LABORATORY AUXILIARIES

On April 30 the staff of the Hanford Laboratories Operation totalled 1167, including 477 exempt and 690 non-exempt personnel. Of the total exempt employees there were 414 with college degrees, including 398 technical degrees as follows:

BS	MS	PhD
200	101	97

In addition there were 36 non-exempt employees with college degrees.

Distribution among the nine level 3 components is included in Table I.

Personnel Development and Communications

Plans were laid during the month for the 1957 summer training program for AEC Radiological Physics Fellows. This year's program will emphasize the practical application of participants' academic training. A ten-week course is scheduled to commence Monday, June 24.

Preliminary planning for the Summer Institute of Nuclear Energy for Engineering College Faculty Members was completed during the month.

At month's end, 22 Technical Graduates and 14 Technician Trainees were assigned within Hanford Laboratories Operation. This represents a decrease of 4 on assignment in each category from March.

Final plans were laid for the Press Tour to be conducted early in May.

Six HLO employees attended the Relations and Utilities course in Data Processing.

Ten employees attended the first presentation of a course on the Prime Contract, and a total of thirty have been scheduled for future sessions.

Ten employees participated in the Area Tour for women this month.

Twenty-six technical articles, speeches and papers were processed during the report period.

Personnel Practices

Suggestions - At the April meeting of the Suggestion Board, 15 suggestions were reviewed and 10 were adopted. Six represented savings of $25,119.33 and 4 represented intangible savings. A total of $1585 was granted in awards.

During April, 33 suggestions were received from HLO employees representing 4.8 suggestions submitted per 100 eligible employees. This compares with 3 per 100 eligible employees during March.

Selective Service - The military status of HLO employees is shown in the following table.

STATUS		Non-Technical	Technical	Non-Technical 1-A	*Critical	TOTAL
Reservists	Standby	11	24	0	1	36
	Ready	19	17	5	2	43
	Total	30	41	5	3	79
Non-Veterans		31	35	22	39	127
TOTAL		61	76	27	42	206

Benefit Plans - Hanford Laboratories participation in the Employee Benefit Plans as of the end of April is listed below:

	April	March
Pension Plan - - - - - - - - - -	97.8	97.7
Insurance Plan - - - - - - - - -	99.5	99.4
Savings & Stock Bonus Plan	59.6	58.6
Savings Plan - - - - - - - - - -	8.7	8.8

Placement & Records - Three non-exempt HLO employees were transferred to other components of the Company during the month. To date these have not been replaced. Twelve transfer requests were received during April.

Four attendance recognition awards were issued during the month, including one seven-year, two one-year and one two-year awards. Three five-year and three ten-year service recognition pins were issued.

Technical Personnel Placement

PhD Recruiting

Twenty candidates visited Richland for HLO interviews. There were 11 offers extended by HLO during April; 9 remain open and two have rejected. In addition and resulting from offers extended prior to April five rejections were received and one candidate placed on the roll. One of the 1955-56 carry-overs who had at first accepted an offer and later withdrew the acceptance has been reactivated and negotiations are continuing.

The status of the HAPO PhD recruiting is shown on Table III.

BS/MS Experienced Recruiting

Seven experienced candidates visited Richland for interviews during April. HLO extended 7 offers, of which 2 were accepted and 5 remain open at this time. Resulting from earlier offers, 4 candidates accepted, 3 rejected and 1 was placed on the rolls. The summary of this activity is shown in Table III.

Union Relations

Negotiations with the Regional Monitors continued during the month and we are currently awaiting a request from the HAMTC for further negotiations.

The Wonacott arbitration case which involves jurisdiction of Radiation Monitors is continuing. The outlook for settlement is not clear at the present time.

As yet no decision has been handed down by the Superior Court Judge regarding the Laundry Arbitration case.

Two grievances were received during the month of April. One was filed by a Millwright against a Laboratory Assistant who had dismantled several pumps and was answered satisfactorily at Step One. The second grievance was filed by an Instrument Technician and pertained to maintenance work on the Analogue Computer. The Step Two answer has been given and no further action has occurred.

Grievances processed by HLO since 9/1/56 now totals 19, including one non-unit grievance. The status of these grievances is outlined in Table V.

Salary and Wage Administration

Planning for the June reconciliation trip is approaching completion. Position guides and organization charts have been sent to the respective salary administrators to permit the greatest possible number of reconciliations during the visit.

Fifteen position audit interviews were completed during the month.

Two consultants from Employee Compensation Service, New York, visited HAPO during the week of April 15 to review the salary administration functions.

The booklet "What's Your Pay Rate?" was distributed to all HLO supervision and all non-exempt employees during the month. To date there has been very little feedback.

Twenty-six engineering assistant jobs and nine clerical positions were audited. Fifteen job descriptions were prepared by the Specialist, Wage Administration for use in the forthcoming survey of semi-technical jobs at other AEC sites.

During the month, all biological attendants and field inspectors in the Biology Operation were reclassified to biological technologists.

Health and Safety

During April, Laboratories personnel worked a total of 198,009 hours with no disabling injuries. Since September 1, 1956 a total of 1,507,098 hours have been completed with no disabling injuries. There were 40 medical treatment injuries with a frequency of 2.02 as compared to 1.98 for the previous month. The frequency for the year to date is 1.81.

Through April 25, 99% of the medical exams scheduled this year were completed.

There were four incidents involving calls on the fire department. Of these only one resulted in loss, that being a spontaneous fire in a barrel of uranium turnings. The estimated loss was $500.00.

Eleven security violation incidents were processed making the 1957 total 40 to date.

The Specialist, Health and Safety consulted with several of the Operations regarding potential hazards and approved three installations.

In addition 11 safety suggestions were evaluated and 7 were adopted.

In conjunction with Fuels Preparation Department, HOL will issue the 300 Area Master Evacuation Plan during the week of May 13.

T. Marshall

Manager
Employee Relations

T.G. Marshall:vf

VISITS TO HANFORD WORKS

Name	Dates of Visit	Company or organization represented & address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas and Buildings Visited
H. H. Hutchinson	4/15-16 & 17-57	General Electric Co. New York, New York	Review HLO Salary Administration Program	H.A. Paulsen T.G. Marshall	No	760 bldg., 700 Area & 3760 Bldg., 300 Area
Morrell Blesh	4/15-16 -17/57	General Electric Co. New York, New York	Review HLO Salary Administration Program	H. A. Paulsen T. G. Marshall	No	760 Bldg., 700 Area & 3760 Bldg., 300 Area
W. W. Grigorieff	4/25/57	Oak Ridge School of Nuclear Studies Oak Ridge, Tenn.	Consult regarding Radiological Physics Fellow Program	D.C.Fleckenstein A.R. Keene H.A. Kornberg D.E. Warner W.J. Bair T.C. Jerman	Yes	108-F Bldg, 141-M Bldg., 146-FR Bldg in 100-F Area 105-KE Bldg, in 100-K Area

VISITS TO OTHER SITES

D.C. Fleckenstein	4/24/57	University of Wash. Seattle, Washington	Consultations regarding Radiological Physics Fellows.	R. Geballe Geo. Farwell Ralph Baltzo		

TABLE III. EMPLOYMENT - TECHNICAL PERSONNEL STATUS

I. Employment

Non-Exempt Employment Status	Mar.	April
Requisitions		
At end of month	40	26
Cancelled	0	14
Received During month	10	9
Filled during month	9	9
Candidates considered		
Total Applications	11	6
Total Transfer Request from other at HAPO	7	5
Total Interviewed	0	0

Non-Exempt Transfer Requests	Mar.	April
Transfer Cases		
Active cases at end of month	43	47
Cancelled	3	2
New during month	6	12
Transfers effected	3	6
Planned Transfers		
Effective during month	0	2

II. Technical Personnel Placement

Ph.D. Recruiting

	Cases Considered	VISITS TO RICHLAND: Extended	Visited	To Visit	Open Invite.	OFFERS: * Extended	* Accepted	* Open	On The Roll
Engineering:									
Chemical	62	32	9	6	5	5	1	3	-
Electrical	20	7	-	5	-	1	-	1	-
Mechanical	23	14	3	2	5	3	2	-	-
Industrial	-	-	-	-	-	-	-	-	-
Metallurgical	41	23	5	4	10	4	-	2	-
Civil	2	-	-	-	-	-	-	-	-
Science:									
Chemistry	221	75	23	13	8	15	1	6	1
Physics	228	105	22	27	25	16	3	5	2
Math - Stat.	45	12	2	2	2	-	-	-	-
Other	40	8	7	1	-	5	3	1	2
DVM	3	-	-	-	-	1	1	-	1
TOTAL	685	276	71	60	55	50	11	18	6

*Offer totals include 12 carry-overs from the 1955-56 season with 3 acceptances not on the rolls as of 9/1/56 and 7 open offers at that time (1 acceptance now rejected, 1 acceptance later rejected and now reactivated and open.)

BS/MS Experienced Recruiting

	Cases Considered	VISITS TO RICHLAND: Extended	Visited	TO Visit	Open Invite.	OFFERS: * Extended	* Accepted	* Open	On The Roll
Engineering:									
Chemical	13**	7	3	-	1	1	-	1	-
Electrical	18	12	6	-	1	3	2	-	1
Mechanical	26	17	11	-	2	5	3	1	2
Industrial	6	4	2	1	-	3	1	1	1
Metallurgical	14	10	6	-	1	3	3	-	1
Ceramic	3	3	3	-	-	3	1	2	1
Other	13	4	1	-	-	-	-	-	-
Science:									
Chemistry	22**	6	2	-	-	2	-	2	-
Physics	10	5	3	-	-	2	1	-	1
Math - Stat.	5	3	3	-	-	3	2	-	2
Other	28	2	2	-	-	-	-	-	-
TOTAL	158	73	42	1	5	25	13	7	9

*Offer totals include 2 carry-overs from the 1955-56 season which were acceptances not on the roll as of 9/1/56.

** 1 Case transferred from ChE to Chem. to correct error.

IV. Exempt Transfer Cases

			April	Mar.
Active cases at end of month			19	19
Total cases since 9/1/56			60	59
(Includes those initiated prior to 9/1/56)				
Initiated by employee		43		43
Initiated by management*		17		16
New cases during month			1	4
Initiated by employee		0		4
Initiated by management*		1		0
Cases closed during month			1	5
Transfers effected:	Within HLO	0		1
	Within HAPO	0		1
	Other G.E.	0		0
Requests withdrawn		1		2
Terminated		0		1

*Includes ROF's, transfers proposed by employee's management, and requests from other G. E. departments.

V. Union Relations

Grievances Processed - September 1, 1956 to date

Total processed 19 (includes 1 non-unit grievance)

Step I

Pending Step I Answer	0
Answered satisfactorily*	9
Pending time limit	0

Step II

Pending Step II Discussion	0
Pending Step II Answer	1
Answered	
Satisfactorily**	8
Unsatisfactorily	0
Pending time limit	1

*Step I grievances which Council indicated a desire to discuss at Step II but not scheduled for discussion within three months are considered settled at Step I.

**Step II grievances in which the Council formally applied for arbitration but for which no further action is taken within three months are considered settled at Step II.

FINANCIAL OPERATION MONTHLY REPORT
April, 1957

Compiled by Members of the
FINANCIAL OPERATION
HANFORD LABORATORIES OPERATION

Personnel

There were no personnel changes in the Financial Operation during April.

Activities

General Accounting Operation

The Manager - General Accounting has started a series of meetings presenting the Prime Contract to personnel in the Hanford Laboratories Operation. These meetings are held every Thursday morning in the conference room in the 3760 Building.

Responsibility for consolidating HLO-SS Accountability quota forecasts was transferred from Laboratories Auxiliaries Operation to General Accounting, effective May 1, 1957.

Informal agreements were reached with AEC concerning a billing policy for consulting services. AEC has informed us they will (1) request the service in writing in each instance (2) inform us whether or not the customer should be billed for the service and (3) companies sending representatives to Hanford should be informed by AEC in advance whether or not they will be billed for the services they are requesting.

The physical inventory of uninstalled catalogued equipment in the custody of the Radiation Protection Operation was completed during April. Reconciliation of the physical count to the property records continues, and a report of the results will be issued upon completion. Progress has been made in reconciling movable property records with the 702 magnetic tape. It is expected that this information will be up-to-date during May.

Cost Accounting Operation

Budget data on the basis of Level 2 and Level 3 components for FY 1959 and Revision for FY 1958 has been submitted to Contract Administration. Work on the detailed budgets for the Level 4 and 5 components is proceeding.

Account class and work identification cost codes were issued in booklet form to Hanford Laboratories personnel during the month. Organization codes for all components were previously distributed.

Personnel Accounting Operation

Shift differential payments to exempt employees, retroactive to February 1, 1957, as approved by AEC were included in salary checks delivered on April 30, 1957.

Quarterly tax returns and summaries were filed or forwarded prior to established due dates. In addition to tax data furnished Accounting Operations, Schenectady, tax returns were filed direct with two states, Idaho and Oregon.

Based on the consumer price index published on April 23, 1957 a cost-of-living allowance of .59% has been announced to be effective April 29, 1957. The increase in salaries resulting for the cost-of-living allowance will be reflected in salary checks delivered to non-exempt employees on May 10, 1957.

In conjunction with Salary and Wage Administration, punch cards representing salary data for each exempt employee, as requested by Employee Compensation Services, were forwarded to Schenectady on April 5, 1957.

General Electric Annual Reports for 1956 were delivered to all employees and annual statements of participation were delivered to those employees participating in Savings and Stock Bonus Plan.

Auditing

Work with the Travelling Auditors was completed on April 10, 1957 with the balance of the month devoted to a review of the T.A. HLO Audit work papers to determine what additional internal audit work will be necessary to complete the 1957 schedule.

Measurements

A special study of the absenteeism in Technical Shops was completed during the month.

Office Procedures

A study was made of all personnel records used in Employee Relations and Financial Operations to scope the problem of coordinating the usage of these records and eliminating existing duplication of files wherever possible. Studies relative to the electronic data processing procedures used by Classified Files and property accounting procedures used in General Accounting Operation continued during the month.

Payroll Statistics

Changes during month	Total	Exempt	Non-Exempt
Employees on payroll at beginning of month	1 171	477	694
Additions and transfers in	8	3	5
Removals and transfers out	(12)	(5)	(7)
Transfers from weekly to monthly payroll	-0-	2	(2)
Employees on payroll at end of month	1 167	477	690

Gross payroll paid	April	March
Exempt	$345 131	$345 928
Non-Exempt (5 weeks in March)	268 212	340 260
	$613 343	$686 188

1240699

Overtime payments	April	March
Exempt	$2 288	$ 3 241
Non-Exempt (5 weeks in March)	3 701	10 350
	$5 989	$13 591

Insurance claims paid	April		March	
	Number	Amount	Number	Amount
Employee				
Life Insurance	-0-	$ -0-	1	$11 297
Weekly sickness and accident	21	844	14	1 623
Comprehensive medical	67	5 775	45	4 446
Dependents				
Comprehensive medical	133	11 114	55	3 409
	221	$17 733	115	$20 775

Good Neighbor Fund	April	March
Number participating	797	801
Percent participating	68.3%	68.4%

Other Statistics

Cash advances and travel expenses		April		March
Advances outstanding at beginning		$15 384		$ 9 872
Advances issued - by checks	35	5 227	61	10 593
- by cash	54	5 538	36	5 305
- air travel orders		7 653		9 629
		33 802		35 399
Less:				
Expense vouchers processed				
Travel expense accounts	63	15 591	54	12 999
Other (movement of household goods, conference expense, etc.)	26	1 321	32	671
Refunds of advances	63	5 176	46	5 404
Billing to and from HAPO components-net		(137)		941
		21 951		20 015
Advances outstanding at close	37	$11 851	40	$15 384
Ages of advances outstanding				
15 days or less	33	$10 378	32	$11 870
16 - 30 days	2	370	8	3 514
More than 30 days	2	1 103		-0-
		$11 851		$15 384

Project Proposals and Appropriation Requests

	Project Proposals	Appropriation Requests
On hand beginning of month	-	-
Received	2	36
	2	36
Recommended for approval	2	32
Recommend for rewrite	-	3
Returned - lack of funds	-	1
Total	2	36
On hand at close of month	-	-
Appropriation requests receiving final Approval during month		
Number	12	
Amount	$74 883	

W. Sale:bk
5-10-57

INVENTIONS OR DISCOVERIES

All persons engaged in work that might reasonably be expected to result in inventions or discoveries advise that, to the best of their knowledge and belief, no inventions or discoveries were made in the course of their work during the period covered by this report except as listed below. Such persons further advise that, for the period therein covered by this report, notebook records, if any, kept in the course of their work have been examined for possible inventions or discoveries.

INVENTOR	TITLE OF INVENTION OR DISCOVERY
D. W. Brite	Densimeter
L. L. Burger F. B. Kuffer	Dibutyl Phosphonoacetic Acid - A New and Potentially Useful Complexing Agent
W. W. Schulz J. L. Carroll	A trough arrangement of the mercury cathode for a Flurex cell which produces nearly uniform current density in the cation exchange membrane.
R. W. Wirta	The Use of a Diffuser Cone in the Inert Gas Arc Welding Process

R. W. Albaugh